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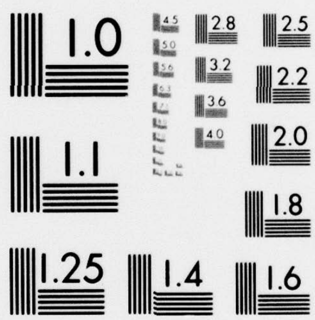

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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(9) Interim Technical Report No. 3, May - Oct 69,

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Report of Work Accomplished In Support of PARKA II Operations

by

(10)

R. C. Latham

Romondt Budd

R. G. Zachariadis

Hawaii Institute of Geophysics
University of Hawaii

Prepared for Office of Naval Research
ONR Contract N00014-67-A-0387-0004 AA

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Director
Hawaii Institute of Geophysics

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UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics
2525 Correa Road
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10 November, 1969

Dr. J. B. Hersey
Director, Ocean Science and Technology
Office of Naval Research, Code 102-OS
Department of the Navy
Washington, D. C. 20360

Dear Dr. Hersey:

Five copies of Enclosure (1) are forwarded as an interim report of work accomplished under ONR Contract N00014-67-A-0387-0004 AA from May 1969 through October 1969. My letter of 9 October, 1969 forwarded the technical report covering the period from May 1968 through April 1969.

This interim report, Enclosure (1), is concerned with work accomplished in support of PARKA II to date. The results from four cruises of USS MARYSVILLE (PCER 857) made in July, August, September, and October, 1969, are described in detail. A summary report of the results from ocean current observations near the Sea Spider site made from TOWNSEND CROMWELL between 18 and 24 September, 1969, is included.

All original data, required by the PARKA II Scientific Plan 2-69 to be delivered to the Chief Scientist upon the completion of each cruise, have been delivered as specified. Daily reports of synoptic observations for transmission to Fleet Numerical Weather Central were made as required. Data from velocimeter stations have been forwarded to the National Oceanographic Center.

Most sincerely,

George P. Woollard

George P. Woollard
Director

RCL:eso
Encl.
cc: ONR San Francisco
ONR Pasadena
R. H. Nichols, BTL
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A. E. White, ONR
K. W. Lackie, NOO
Capt. P. M. Wolff, FNWC
D. C. Pauli, ONR
H. Aurand, ONR

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ABSTRACT

The report entitled "Oceanographic Parameters for Acoustical Determination Between Latitude 22°N and 30°N Along the 157°50' West Meridian" described a one-year environmental study made between May 1968 and April 1969. This interim report describes the work accomplished from May 1969 through October 1969.

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The results of five ship cruises are reported which confirm the variability of the near-surface ocean environment in the area. A definite temperature inversion in the deep ocean below about 3800 meters depth is described. Several bathymetric profiles are presented, the results of current observations near the Sea Spider site are reported and the results from analysis of three cores taken by USNS SANDS at the Sea Spider site are reported.

Report of Work Accomplished
In Support of PARKA II Operations
May 1969 through October 1969.

1. Introduction: ONR Contract N00014-67-A-0387-0004 effective from 1/1/68 through 12/31/68 provided for an environmental study of the ocean area north of the Hawaiian Islands to about latitude 30°00'N between longitudes 154°00'W and 162°00'W. The work entailed observations of temperature and the speed of underwater sound at varous depths from the surface to deep depths using a ship operated deep velocimeter. Bathymetric profiles were also obtained. Aircraft flights using AXBT were employed in area studies of water mass boundary conditions. Observations were made each month for 12 consecutive months commencing in May 1968 and completing in April 1969. The objective of the environmental investigation was to study the seasonal variability of sound velocity and long range sound propagation. During the observational period the planned operations were altered to provide support for Pacific Acoustic Research Kaneohe - Alaska (PARKA) Experiments. The original ONR Contract was extended by Contract 0004 AA covering the period from 1/1/69 through 12/31/69 in order to complete the investigation as planned and in order to provide support for PARKA II. The technical report of the one-year environmental study was submitted to ONR on 9 October, 1969, and instructions from ONR regarding distribution of the report are now being awaited. The various reports required for PARKA I have been submitted. This interim report covers PARKA II support during the period from May 1969 through October 1969.

2. Ship Operations:

USS MARYSVILLE (PCER 857) made four cruises between May 1969 and October 1969 in support of PARKA II and R/V TOWNSEND CROMWELL made one as follows:

USS MARYSVILLE (PCER 857)

Cruise No.	Dates	General Track	Purpose
1.	22 July - 1 Aug., '69	Great Circle Seattle to Honolulu	Bathymetry and environmental observations
2.	27 Aug. - 4 Sept., '69	To Sea Spider Site	Support implantment
3.	18 - 29 Sept., '69	Great Circle from Site towards Seattle	Obtain missing bathymetry and environmental observations
4.	4 - 17 Oct., '69	To Sea Spider Site	Support implantment
		R/V TOWNSEND CROMWELL	
1.	15 - 26 Sept., '69	To Sea Spider Site	Current meter measurement at lat. 27°37'N, long. 157°53'W, test of high resolution sonar, and biological observations

3. General Results:

A. The one-year environmental study reported under date of 9 October, 1969, shows that marked changes in water column thermal structure are found in the region of 27°N to 29°N latitude 158°W longitude. Saw tooth flight patterns in an east west direction over this region using AXBT drops show that the anomalous thermal structure is related to persistent eddy-type turbulence in the upper 300 meters of the ocean, which migrated both in latitude and longitude. The present measurement series, as did the previous year's study, reveals no clear seasonal dependency of this feature either in terms of location or structure.

The temperature profiles of this report (Fig. 1, 2, and 3) which show a strong thermal gradient at latitude 26°N on 31 July - 1 August and no gradient at this location on 18 - 20 September and 28 - 29 September, demonstrate the continued variability of the water mass in this region.

B. A definite temperature inversion has been clearly shown to exist in

the North Pacific along longitude 157°50'W between the Hawaiian Islands and the Aleutian Islands and along the great circle course between Lat. 27°30'N Long. 157°44'W and Lat. 48°17'N Long. 122°37'W. The temperature minimum is found at about 3800 meters and the temperature increases progressively with increasing depth to at least 5400 meters, and probably to the bottom. The amount of increase from 3740 meters to 5390 meters was measured as 0.09°C. The locations of the stations at which a definite temperature inversion was measured are shown in Fig. 4. An expanded temperature profile from 2000 meters to 5000 meters demonstrates the temperature inversion and is shown in Figure 5.

C. The requirements for PARKA II support usually prevented making deep velocimeter measurements frequently enough to permit construction of a horizontal sound velocity profile over the track. The MARYSVILLE cruise from Seattle to Honolulu was an exception and the sound velocity profile and temperature profile for this run are shown in Figures 6 and 7. Vertical profiles of sound velocity and temperature as obtained from velocimeter stations of opportunity are presented in Figures 8, 9 and 10. Vertical profiles of temperature as obtained from XBT stations made on schedule near the Sea Spider site are presented in Figures 11 through 19.

D. The bathymetric profile over the great circle course from Seattle to the Sea Spider site is shown in Figure 20. The continuous profile was obtained from data provided by two different MARYSVILLE cruises. The September cruise provided a second profile parallel to the first, but located three miles southeast of the other track. Definite similarities can be seen, but the character of major features is different because of the separation of the tracks. The differences demonstrate that the bottom contours along this route are irregular: for prediction of bottom limited acoustical propagation along the track, one can only hope to use a representative profile. A precise bottom

profile would only be applicable if source and receiver positions were controlled within navigational tolerances of a fraction of a mile. Three bathymetric profiles between Oahu and the Sea Spider site are shown in Figures 21, 22 and 23. Here also there are similarities, but major features are different because of the difference in tracks. Where possible the bathymetric profiles shown here have been compared to USNOO USOC bathymetric charts and excellent agreement is found. Depths are uncorrected, based upon a standard sound speed of 4800 ft./sec. Navigational positions were determined by Omega, Loran and celestial observations, but because of uncertainties in each of these techniques in the Pacific, errors of as much as three to five miles in position may be present upon occasion.

E. Four Geodyne current meters Mod. 102-0 were implanted near the Sea Spider site on 18 May, 1969. All four current meters were planted in a deep-sea mooring at 27°37'N, 157°53'W to measure over a period of eight weeks. On the retrieval date a sea and air search was made during excellent weather conditions, but the mooring was not found. All four current meters must be considered as lost. This loss was reported on 27 August, 1969 to the ONR San Francisco Area Office.

The current meter observations near the Sea Spider site made during the period of 18 - 24 September, 1969, showed a current of 0.6 to 0.8 knots setting 300°T at a depth of 35 meters, 0.4 knots setting 320°T at 150 meters, 0.3 to 0.4 knots setting 300°T at 300 meters, and 0.6 knots setting 360°T at 1,000 meters. The location of this current meter string is shown in Figure 4.

4. General Notes:

Details regarding the four cruises of USS MARYSVILLE may be found in the cruise reports submitted as Appendices A through D. A general analysis of the temperature inversion noted in paragraph 3.B. may be found in Appendix E. An

analysis of the current meter observations noted in paragraph 3.E. may be found in Appendix F.

As the R/V TOWNSEND CROMWELL from the Bureau of Commercial Fisheries, Honolulu, which was used to plant and recover current meters during the period 15 - 26 September, 1969, was equipped with a special high-resolution sonar for fish detection, this sonar was used on this cruise for motion studies of submerged moored objects and for the evaluation of biological concentrations around such objects. A report by Dr. Antares Parvulescu on these objectives is included as Appendix H.

Analysis of the bottom cores taken at the Sea Spider site by USNS SANDS in August 1969 have been completed and are reported by Dr. Fan in Appendix G. Preliminary results were reported directly to the project offices prior to the Sea Spider implantment.

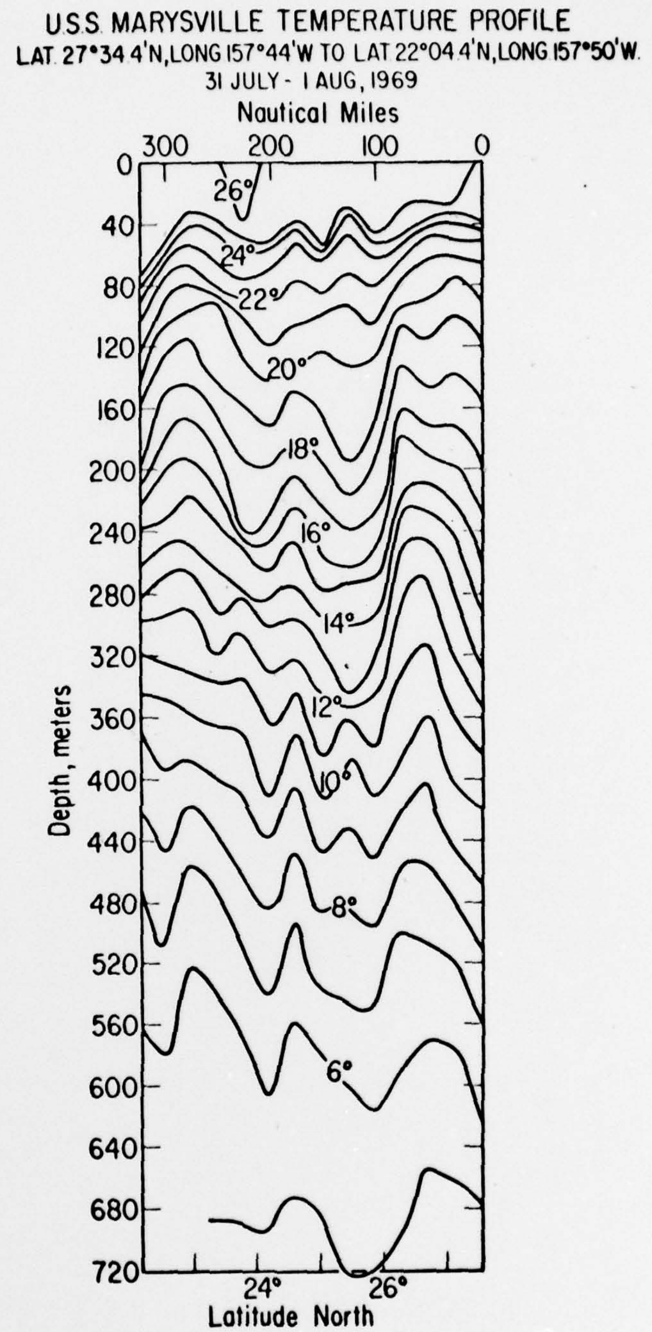


Fig. 1. Temperature ° C 31 July - 1 Aug., 1969.

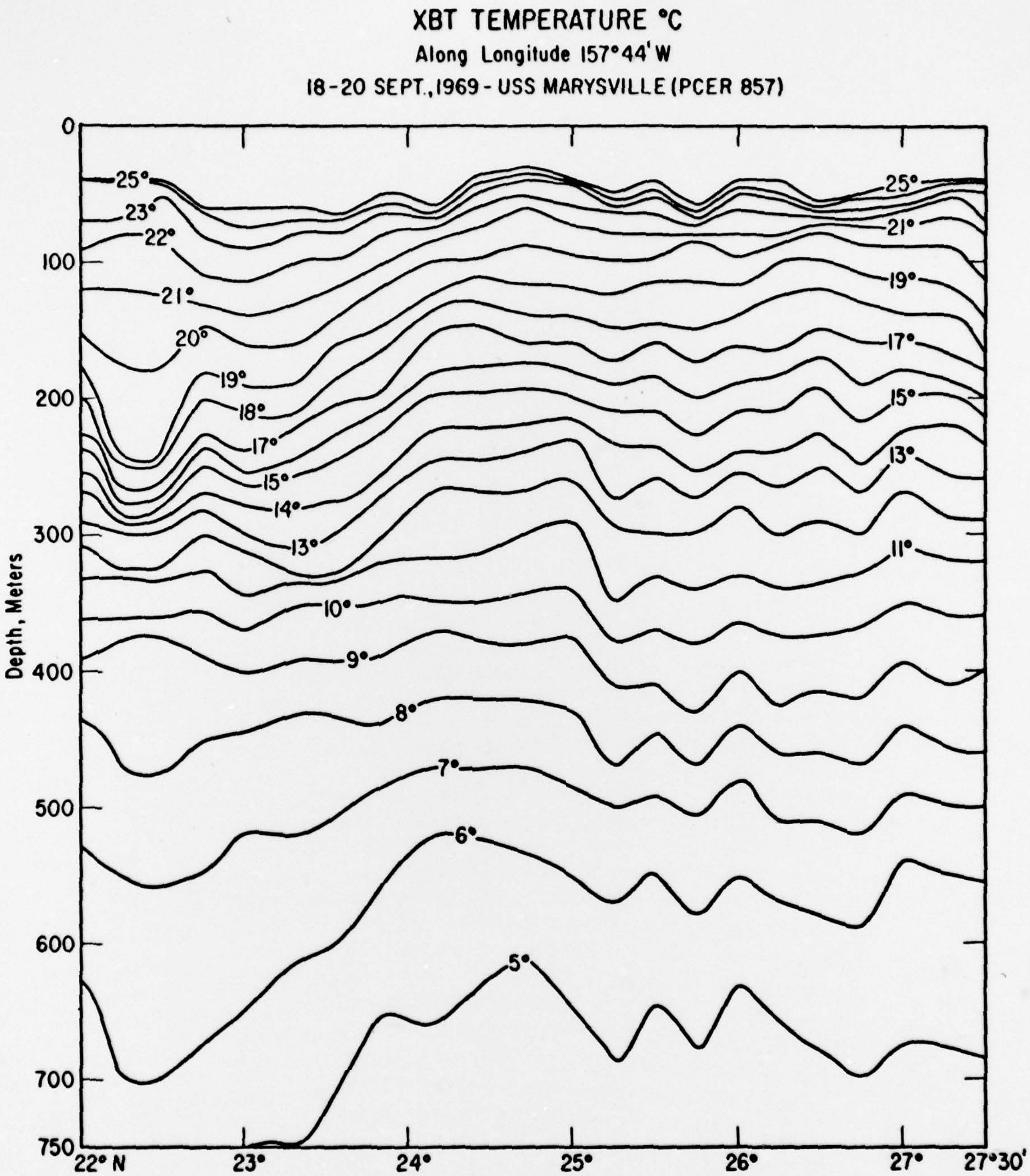


Fig. 2. Temperature ° C 18-20 September, 1969.

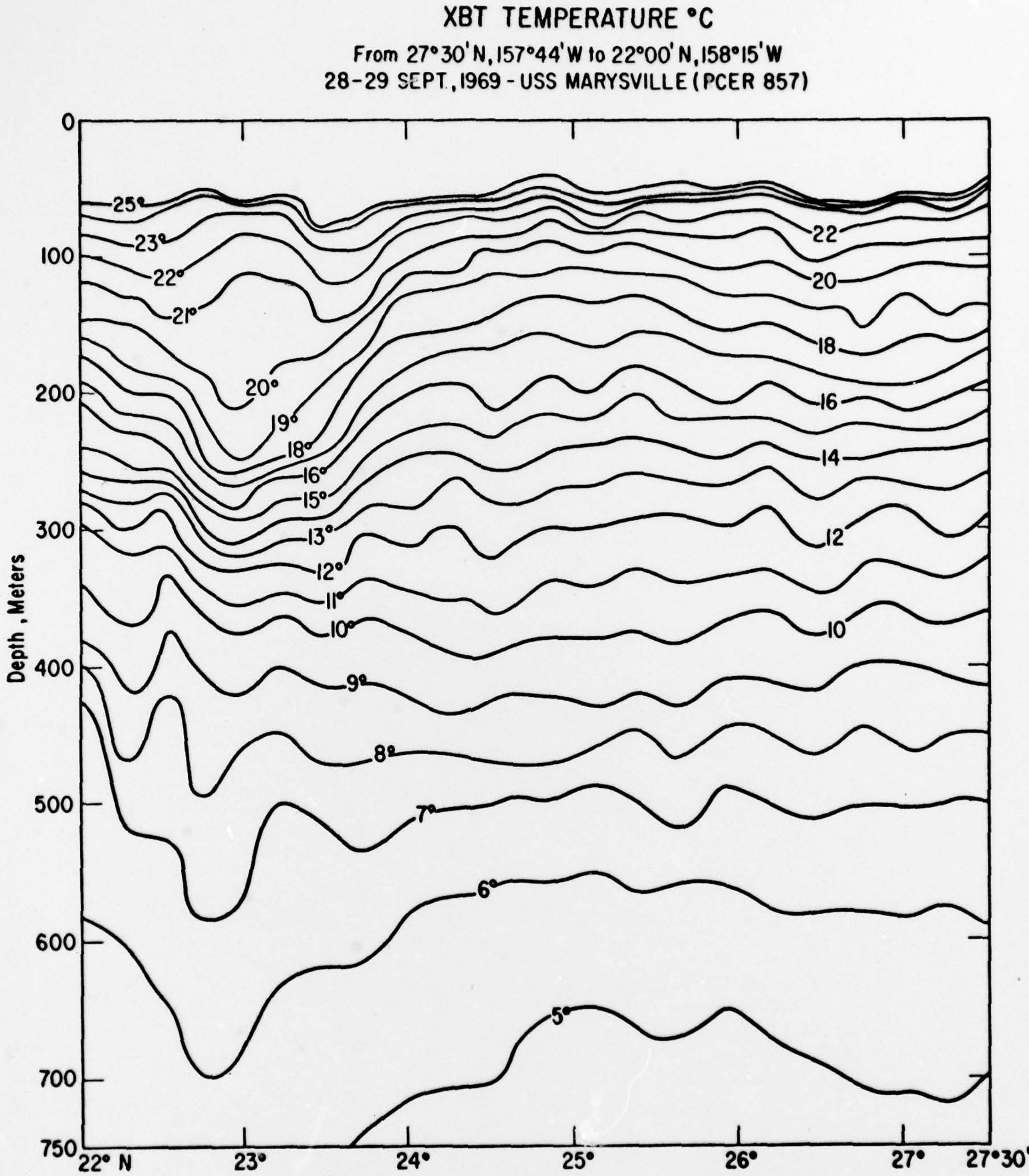


Fig. 3. Temperature ° C 28-29 September, 1969.

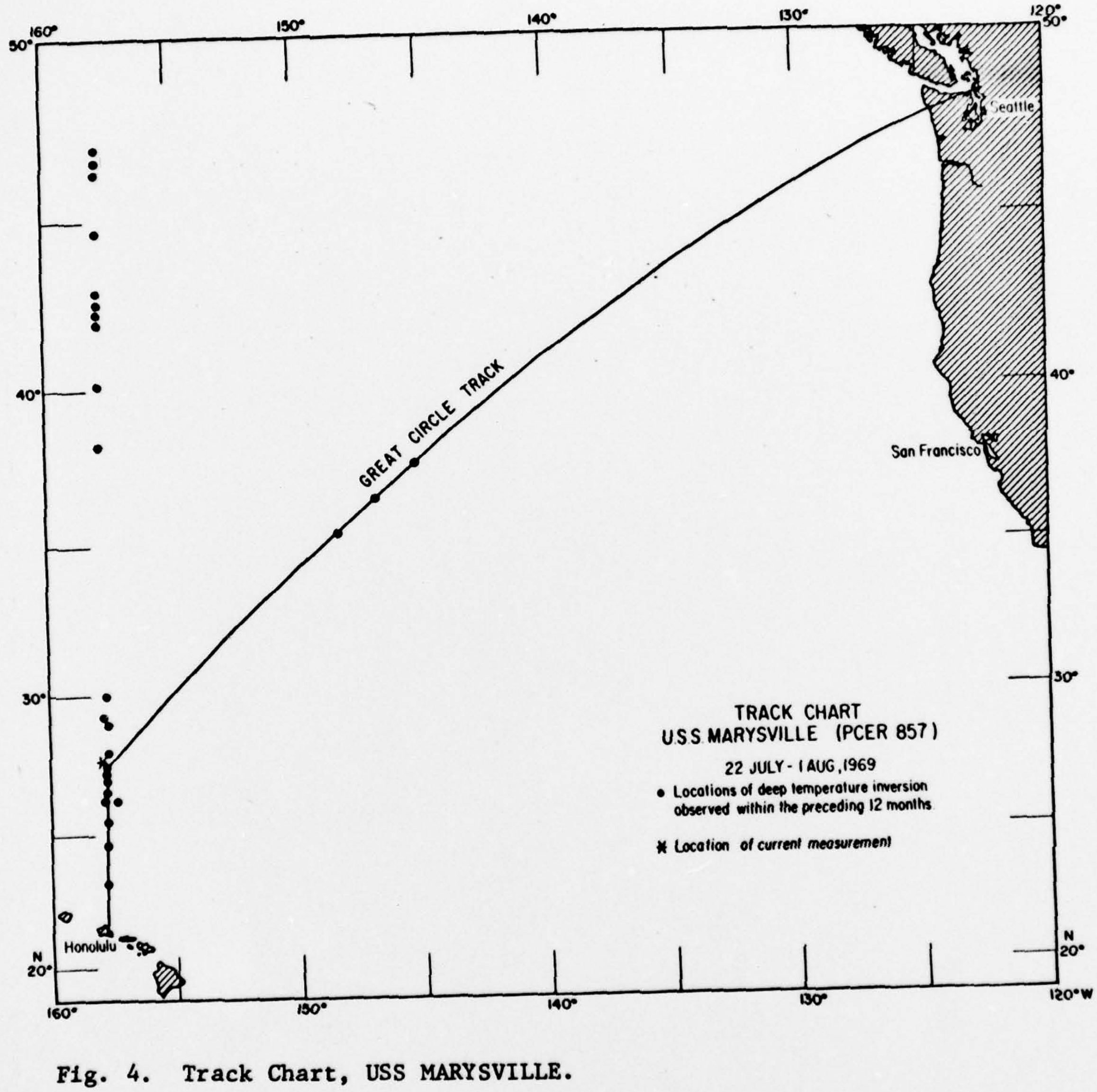


Fig. 4. Track Chart, USS MARYSVILLE.

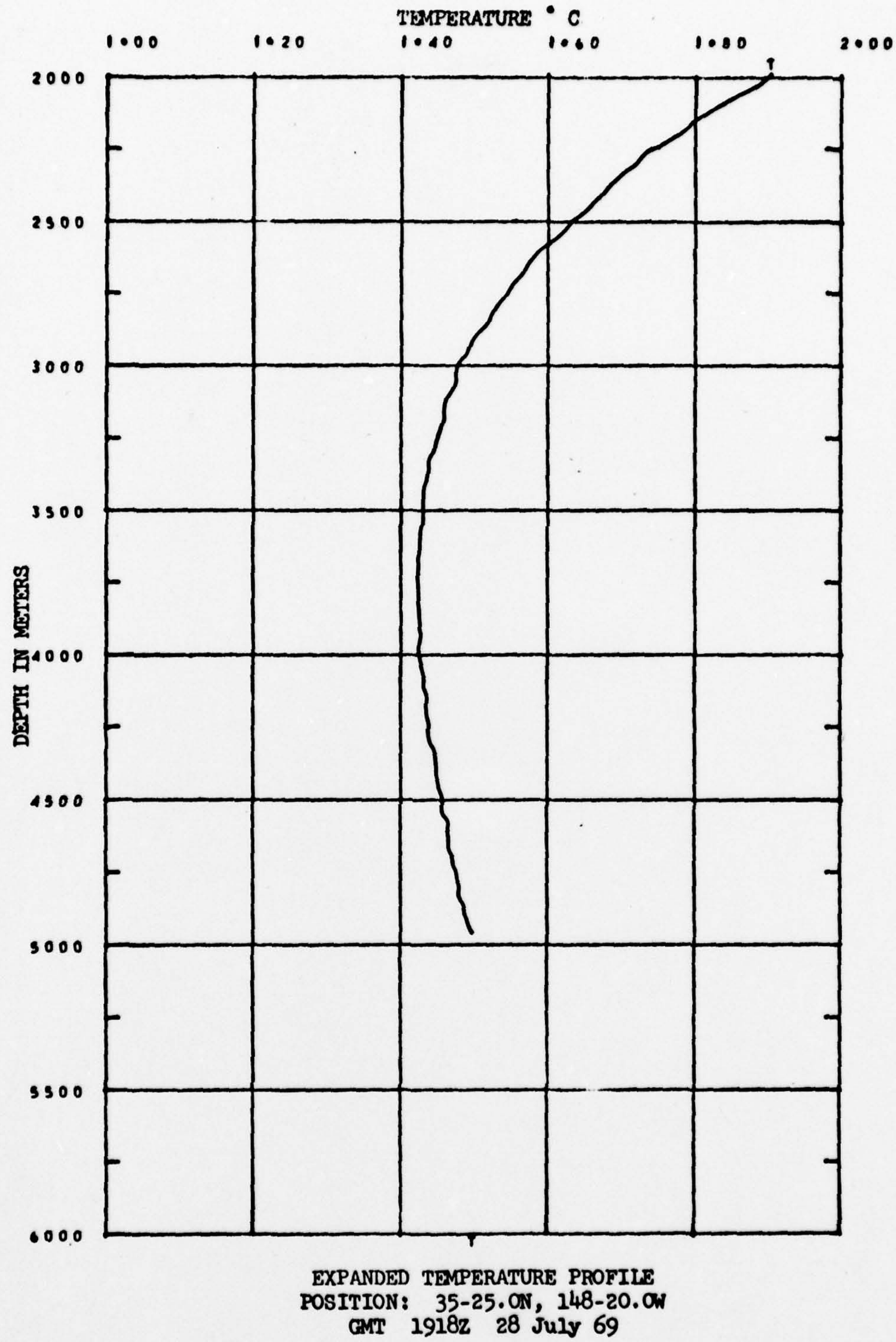


Fig. 5. Expanded Temperature Profile Showing Temperature Inversion.

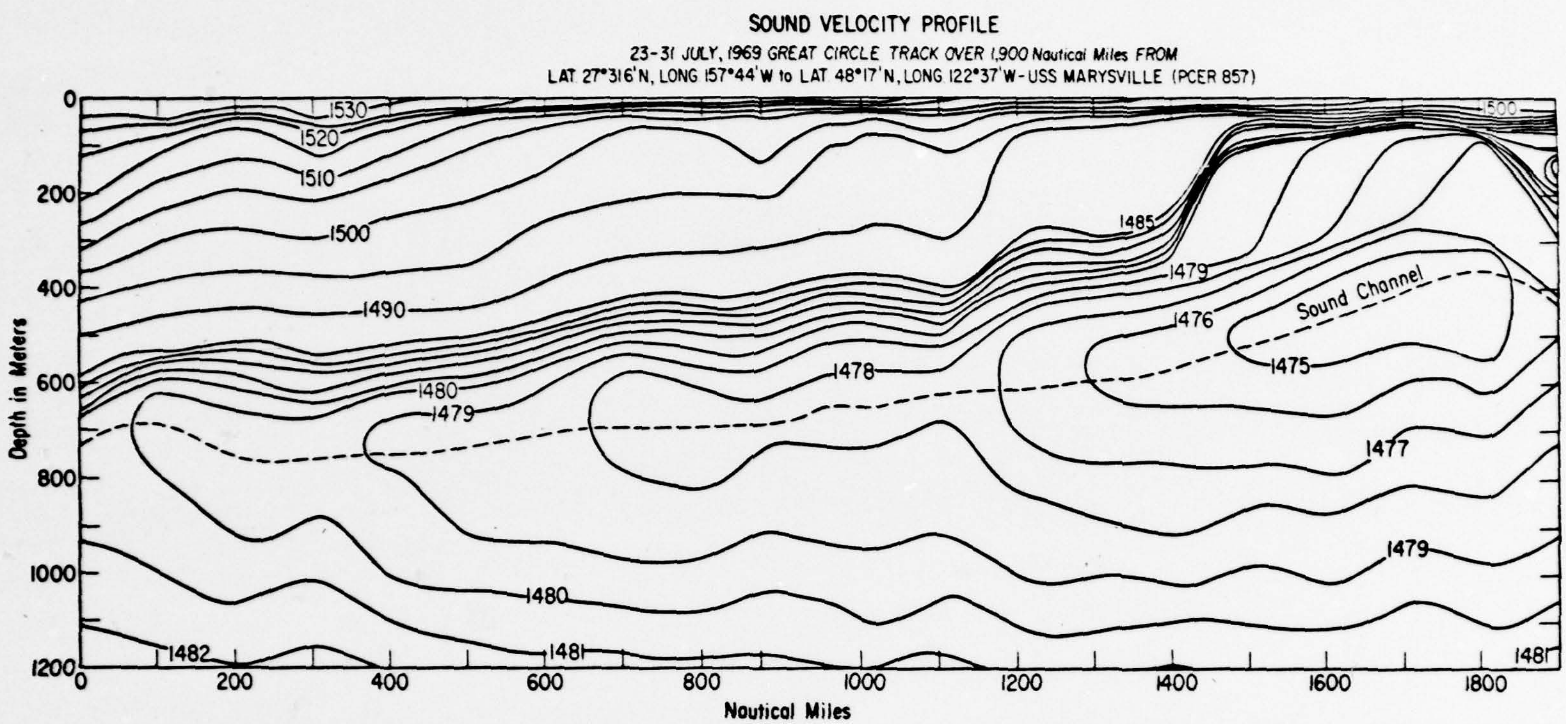


Fig. 6. Sound Velocity Profile, USS MARYSVILLE.

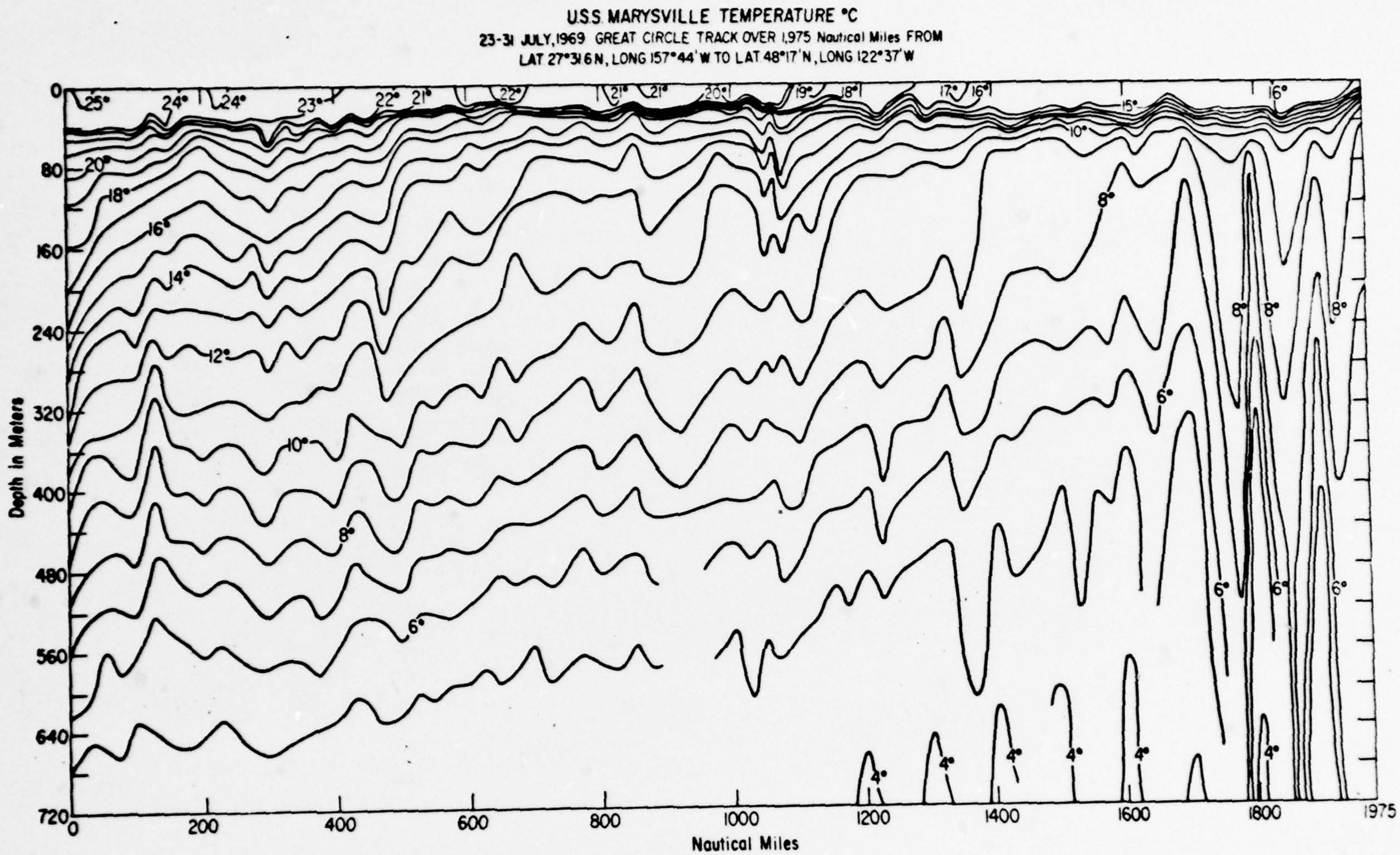


Fig. 7. Temperature Profile, USS MARYSVILLE.

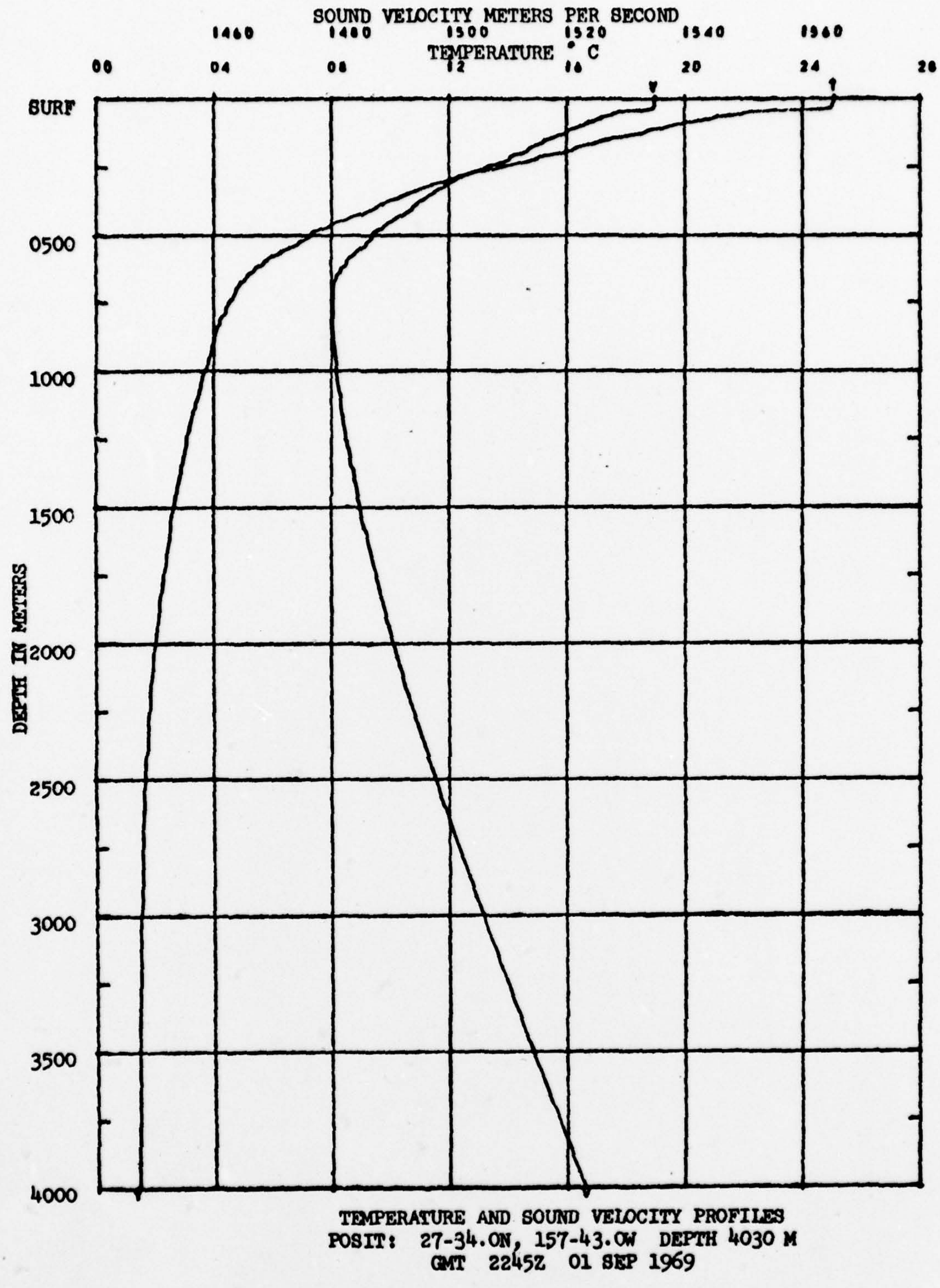


Fig. 8. Temperature and Sound Velocity, 1 Sept., 1969.

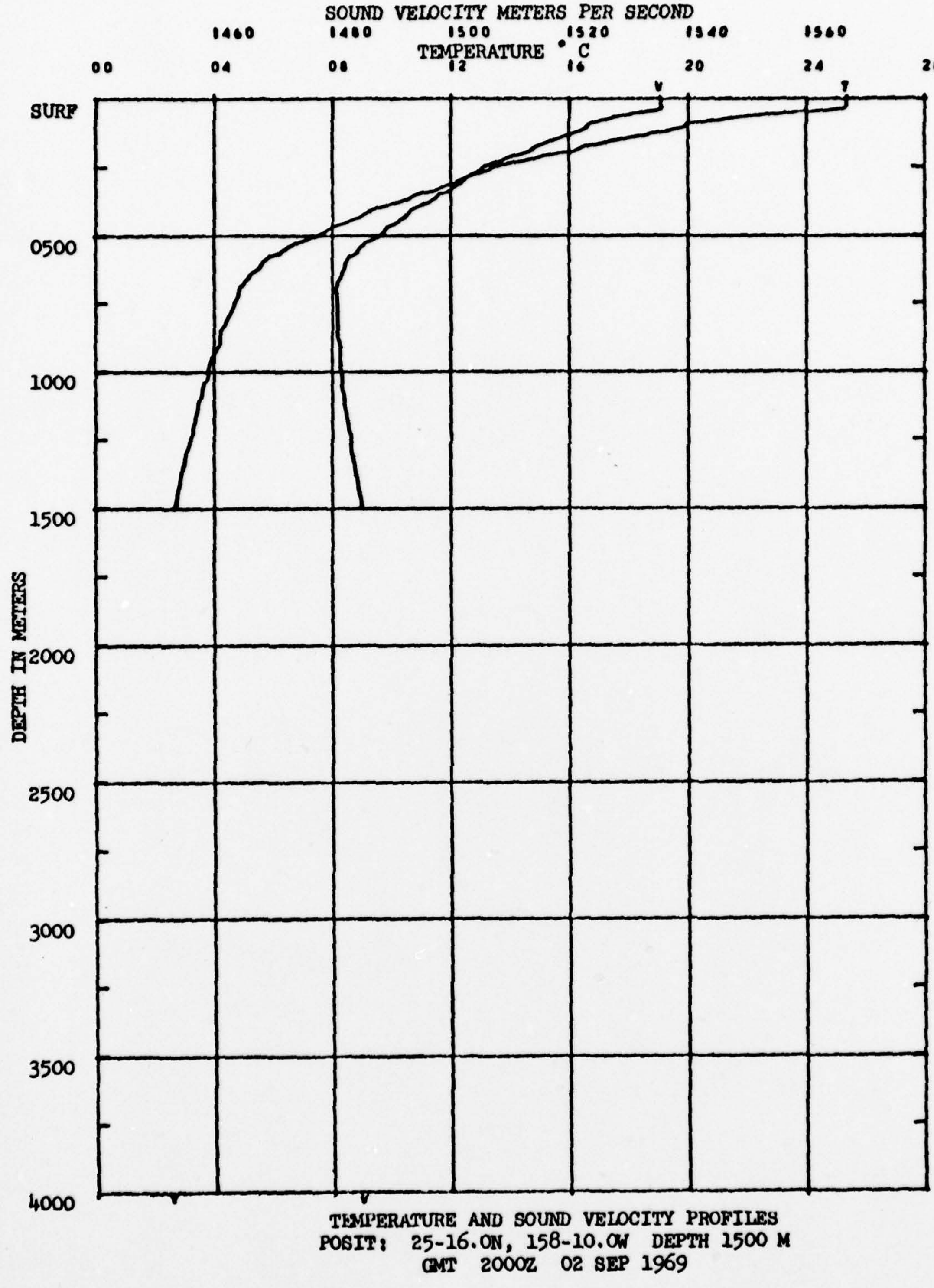
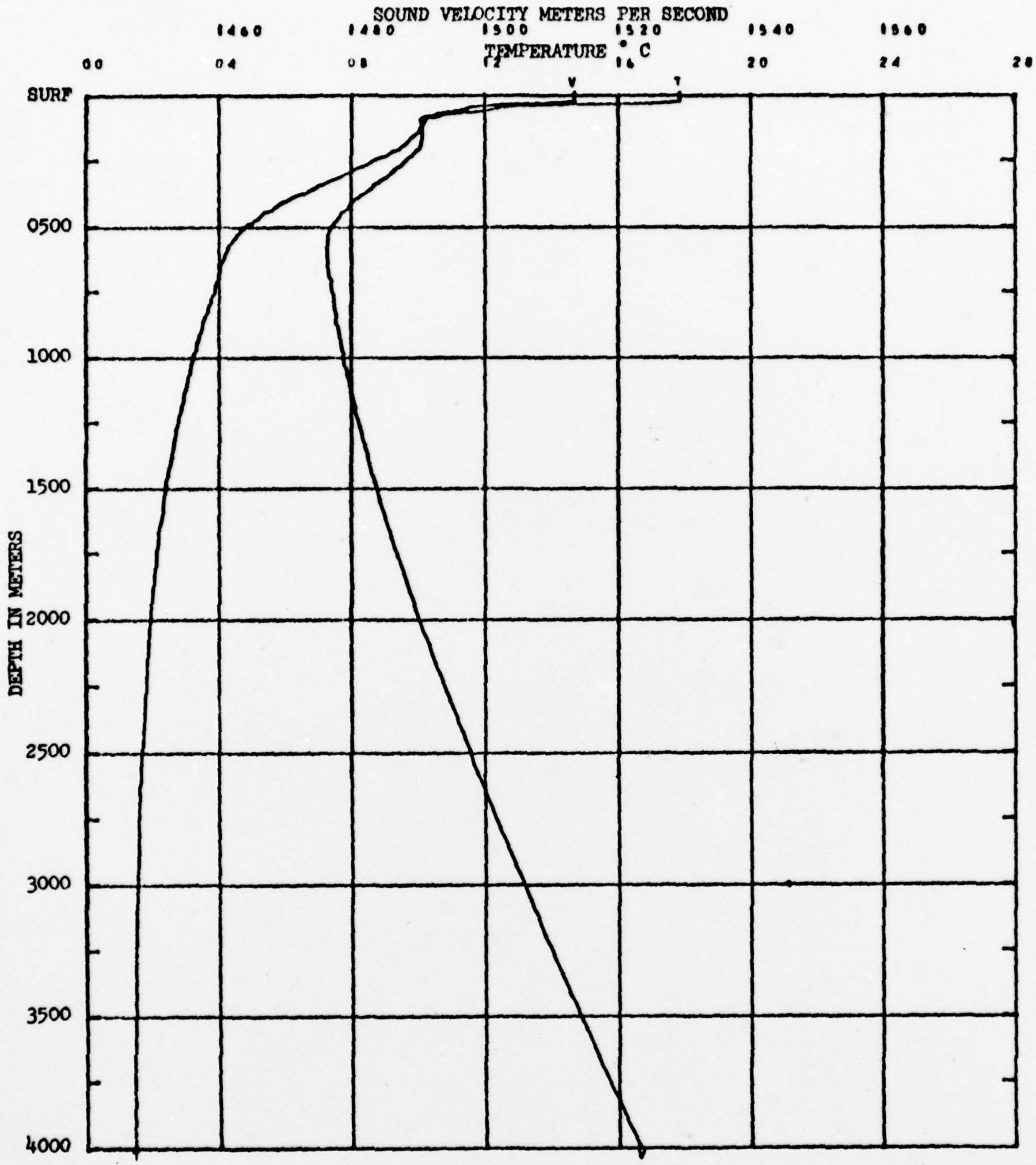


Fig. 9. Temperature and Sound Velocity, 2 Sept., 1969.



TEMPERATURE AND SOUND VELOCITY PROFILES
POSIT: 40-25.5N, 140-34.0W DEPTH: 4130 M
GMT 1800Z 24 SEP 1969

Fig. 10. Temperature and Sound Velocity, 24 Sept., 1969.

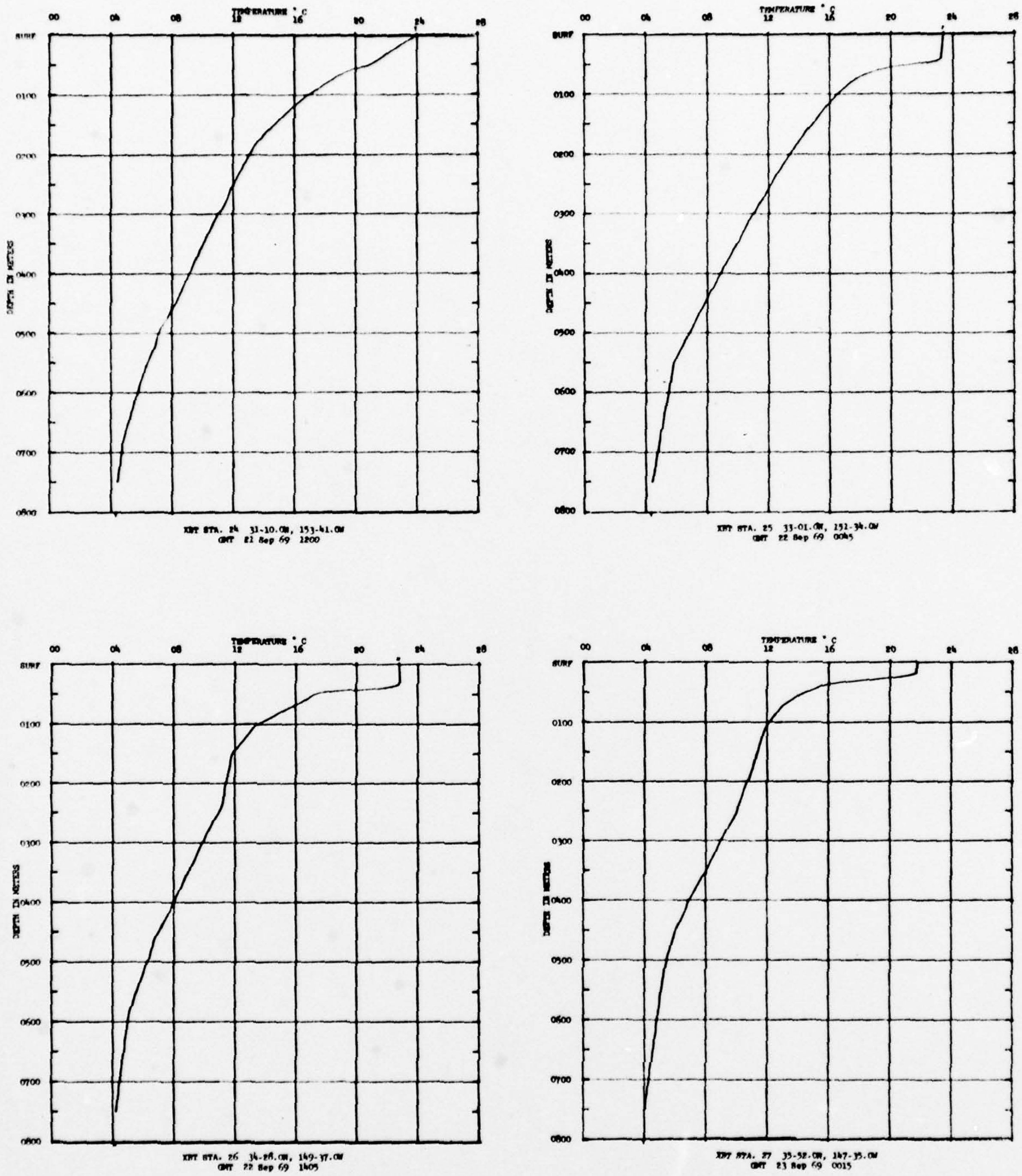


Fig. 11. XBT Profiles, 21-23 September, 1969.

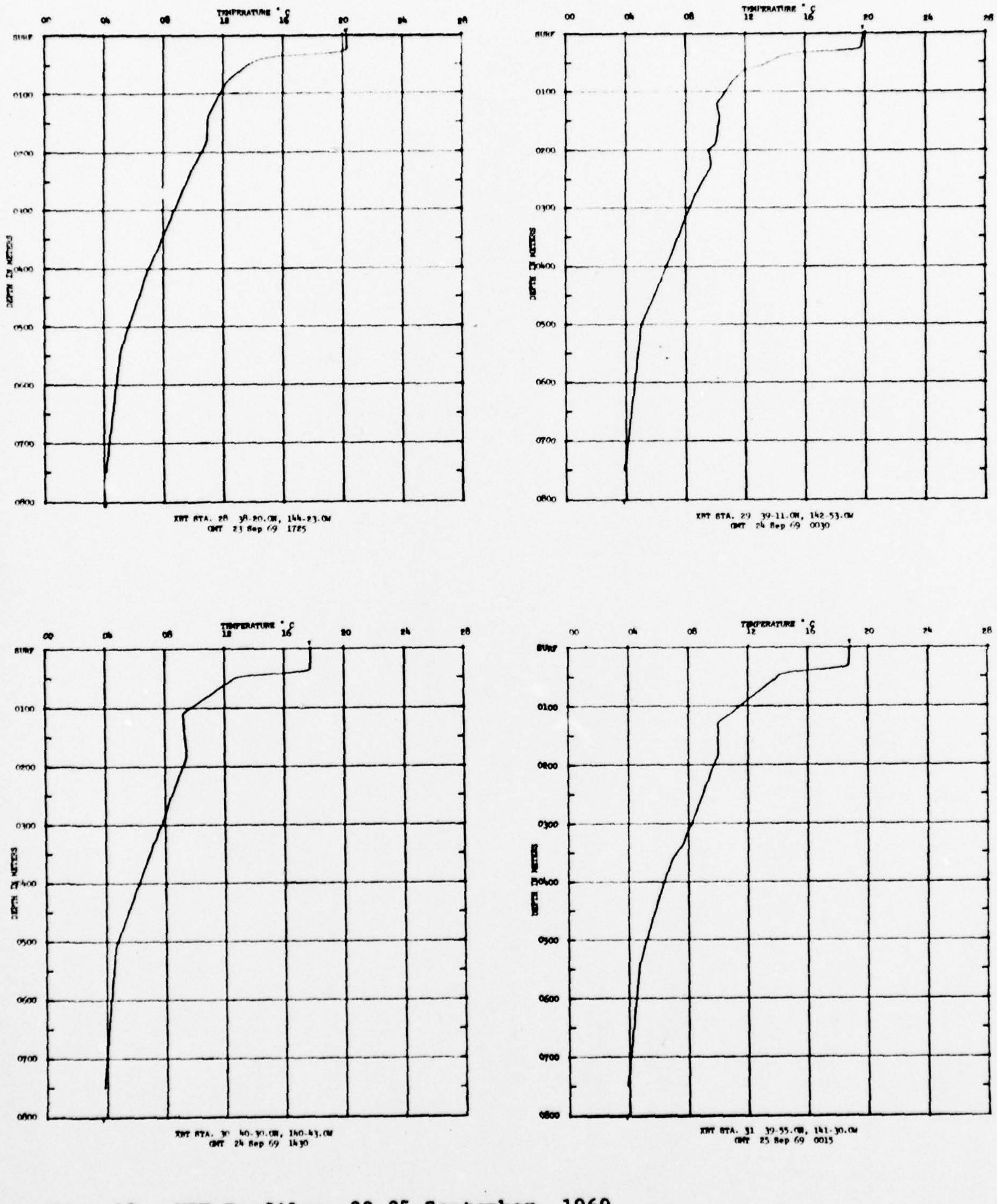


Fig. 12. XBT Profiles, 23-25 September, 1969.

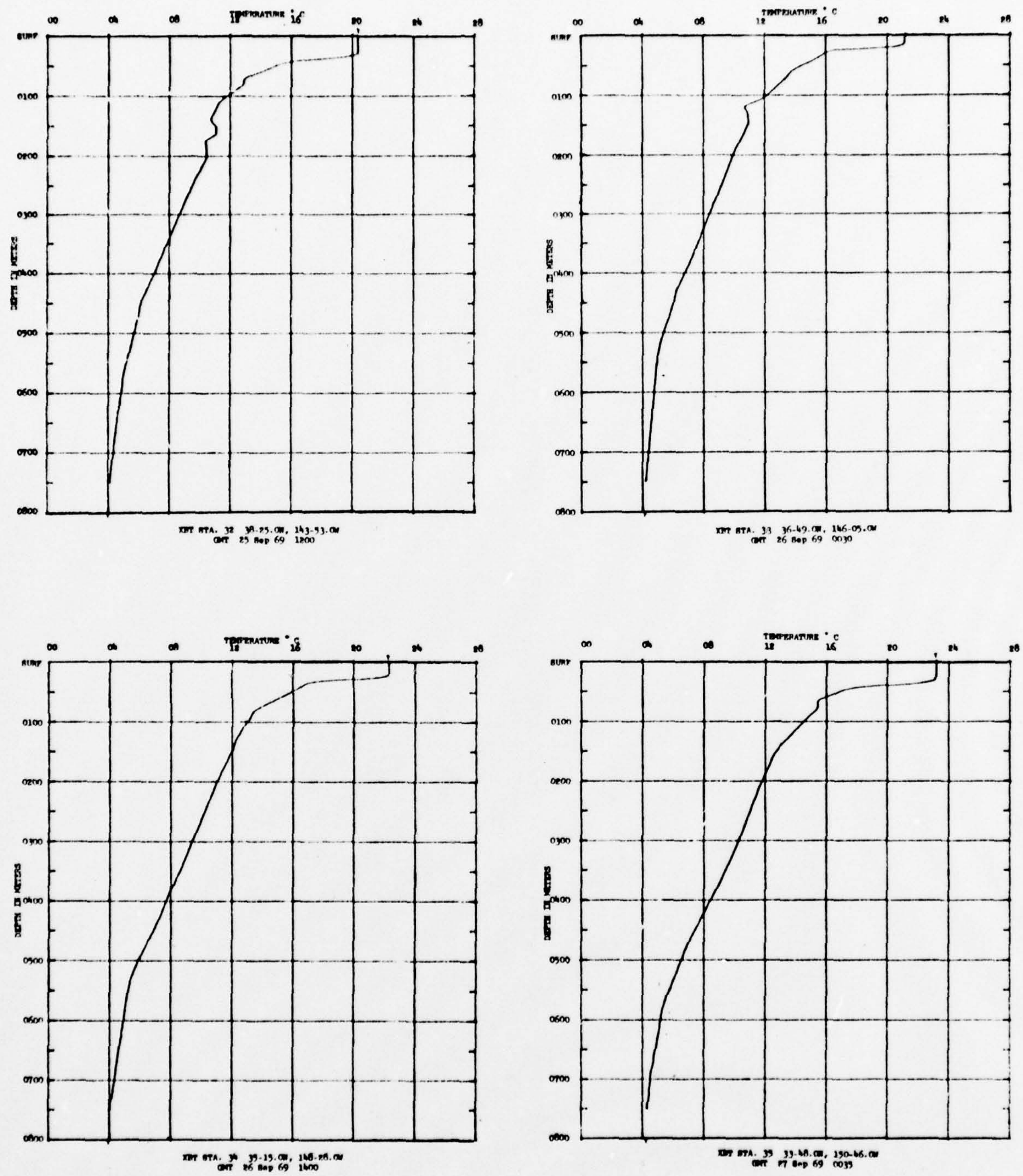


Fig. 13. XBT Profiles, 25–27 September, 1969.

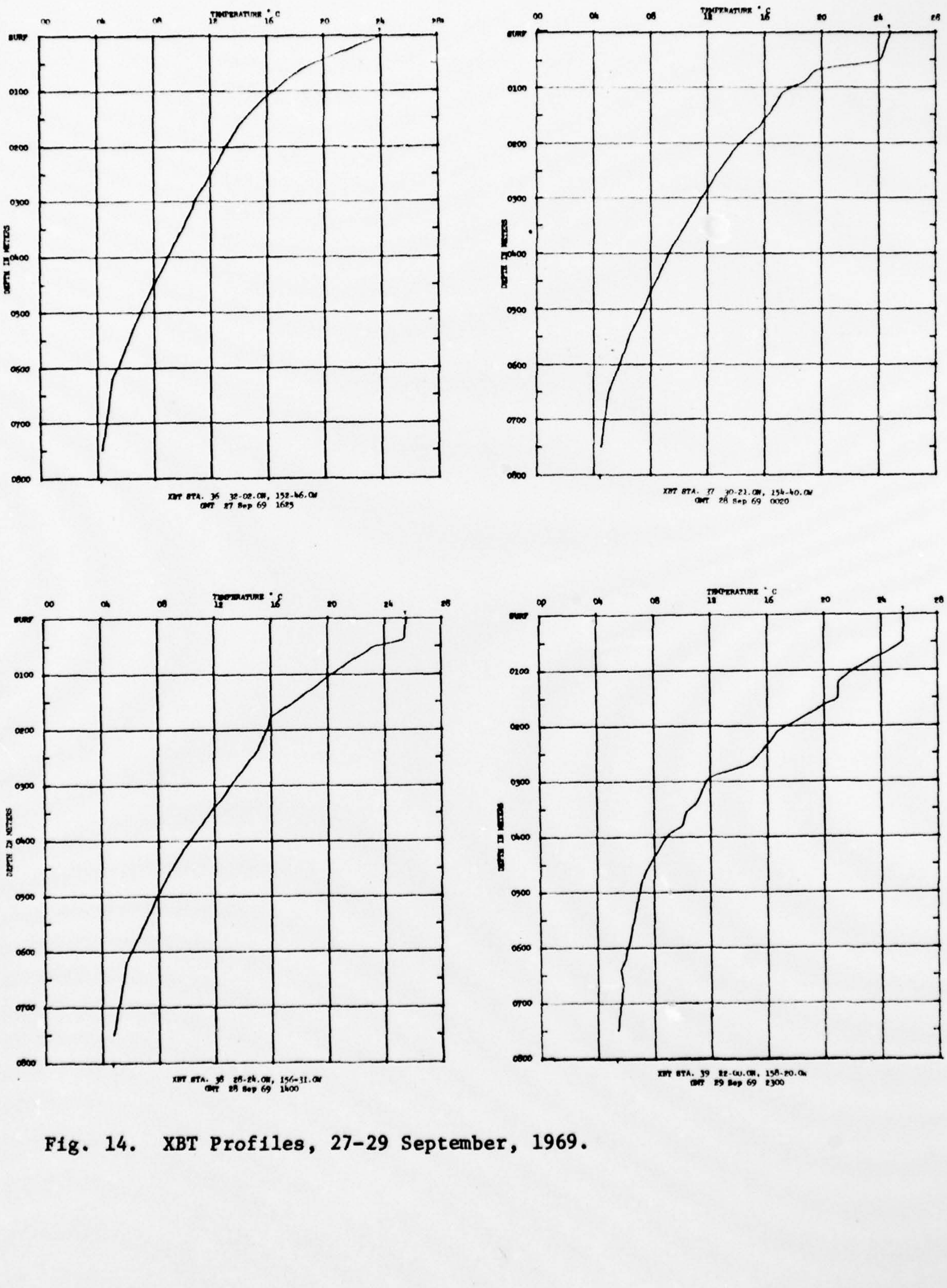


Fig. 14. XBT Profiles, 27-29 September, 1969.

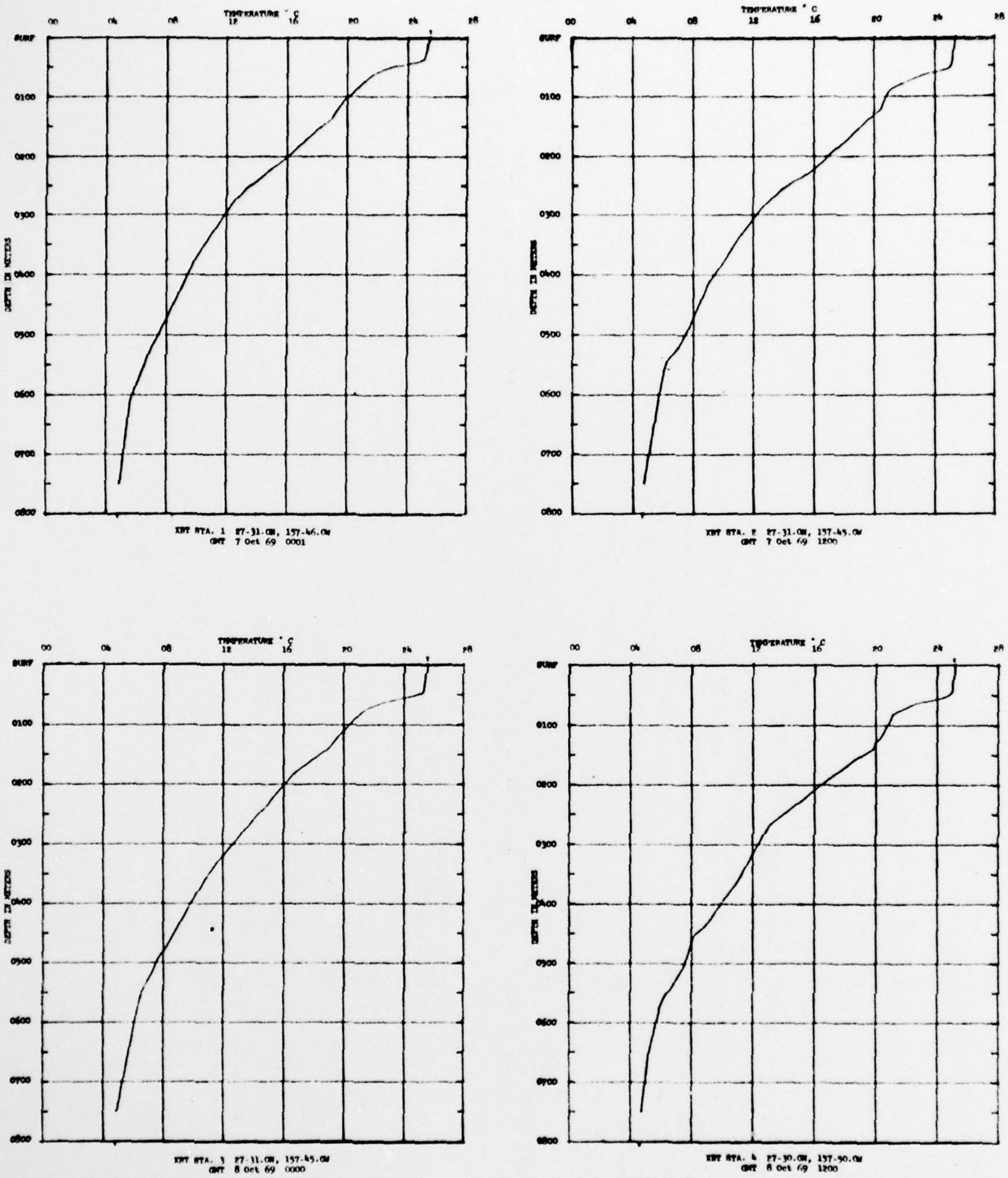


Fig. 15. XBT Profiles, 7-8 October, 1969.

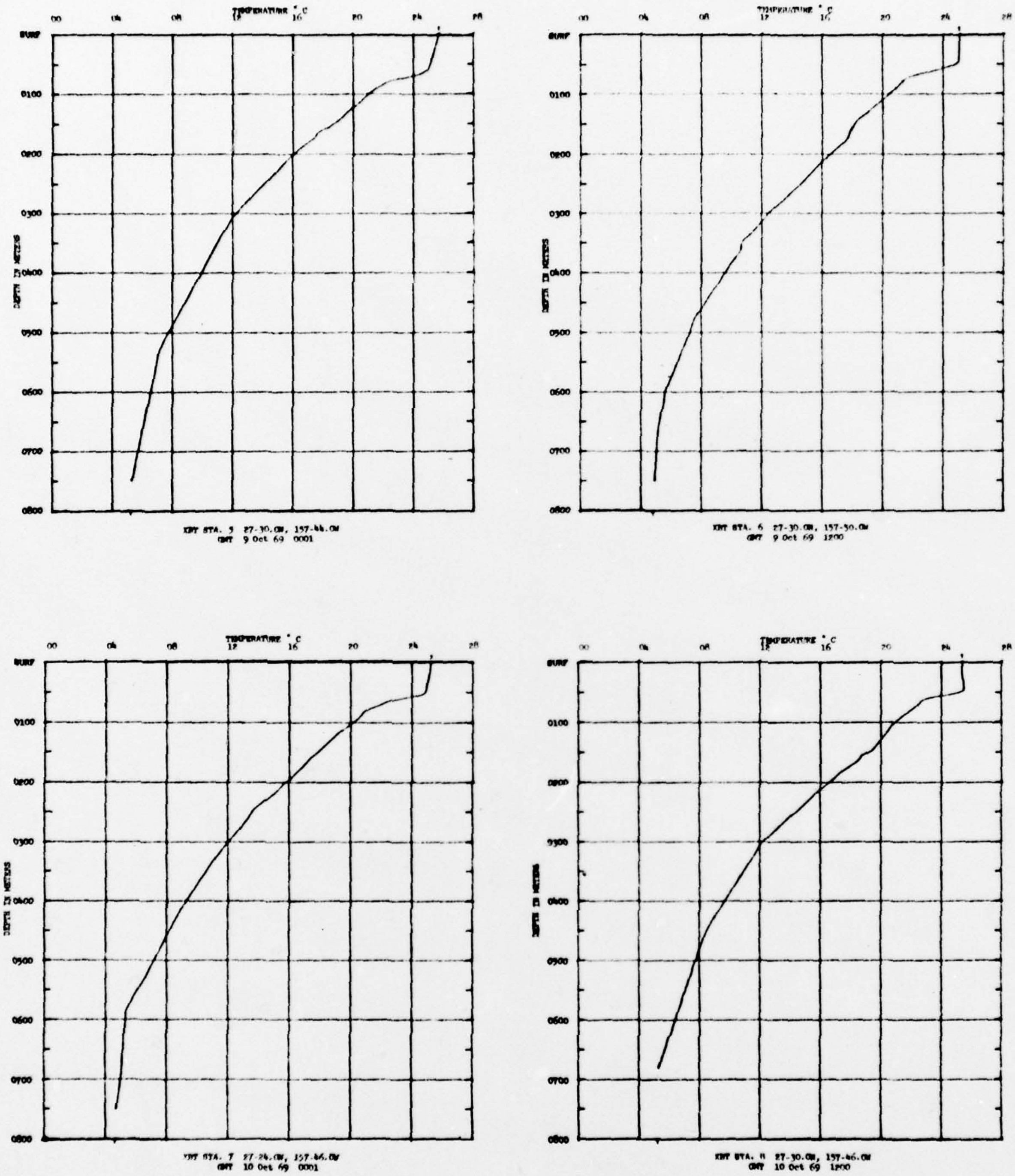


Fig. 16. XBT Profiles, 9-10 October, 1969.

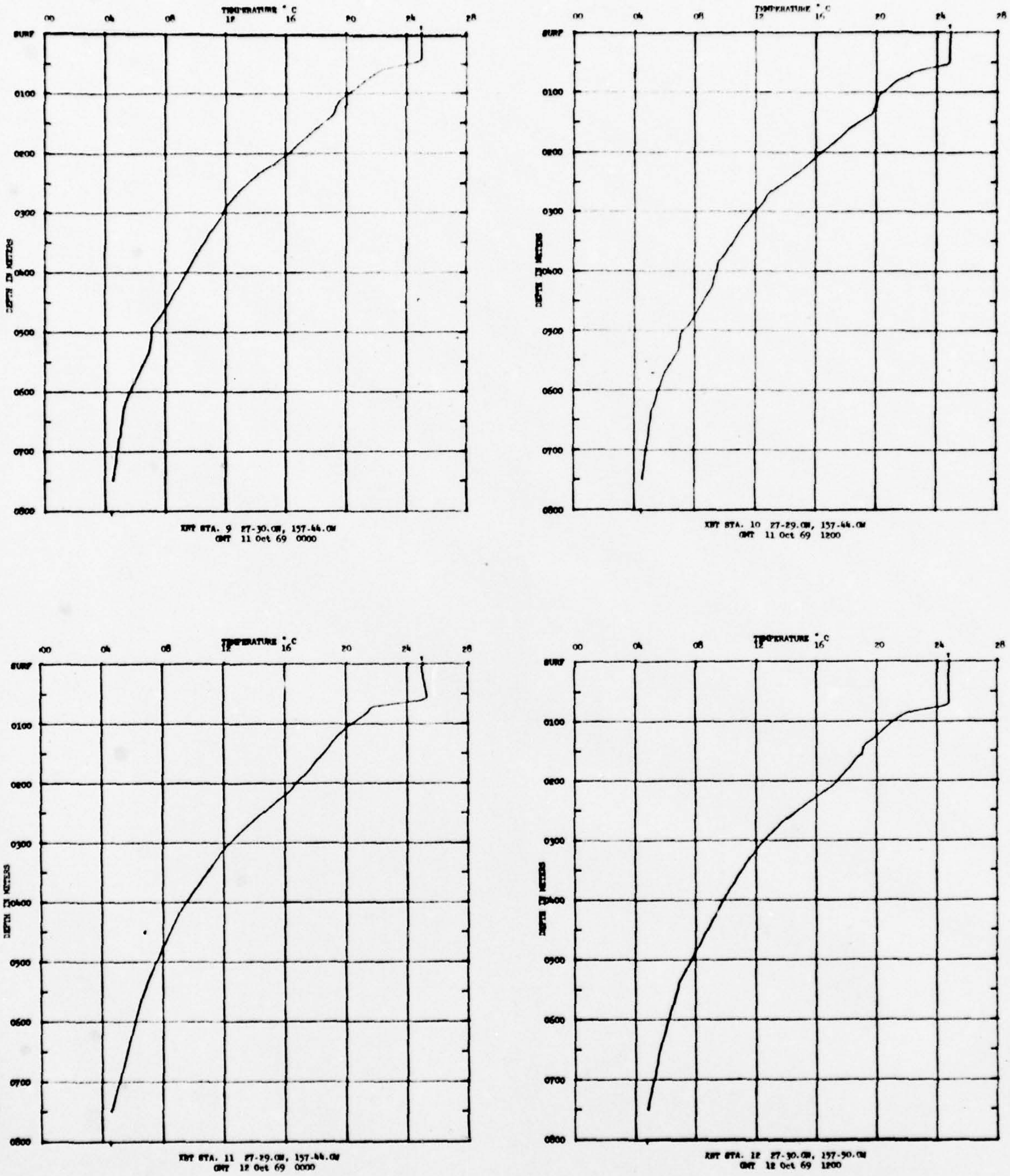


Fig. 17. XBT Profiles, 11-12 October, 1969.

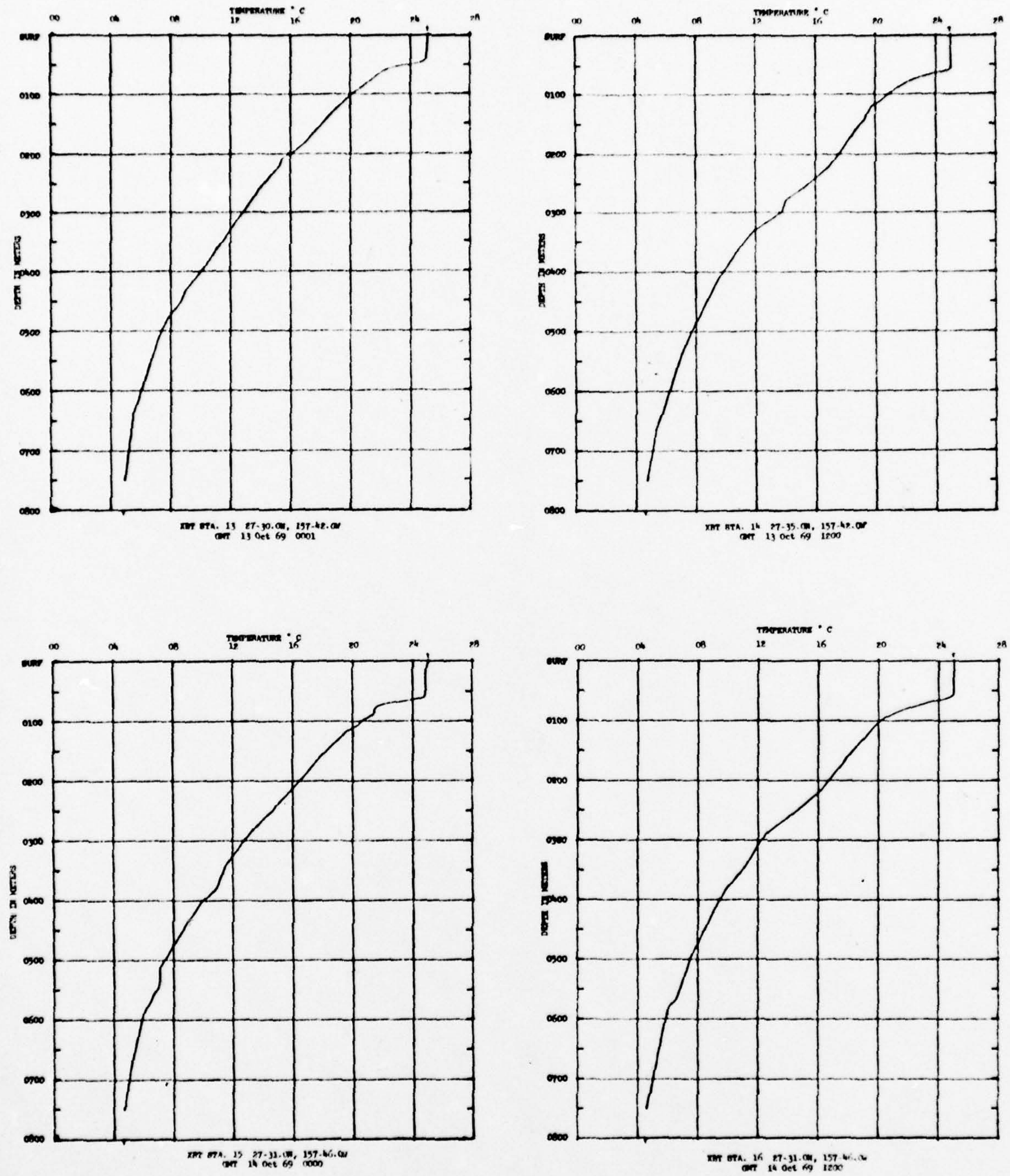


Fig. 18. XBT Profiles, 13-14 October, 1969.

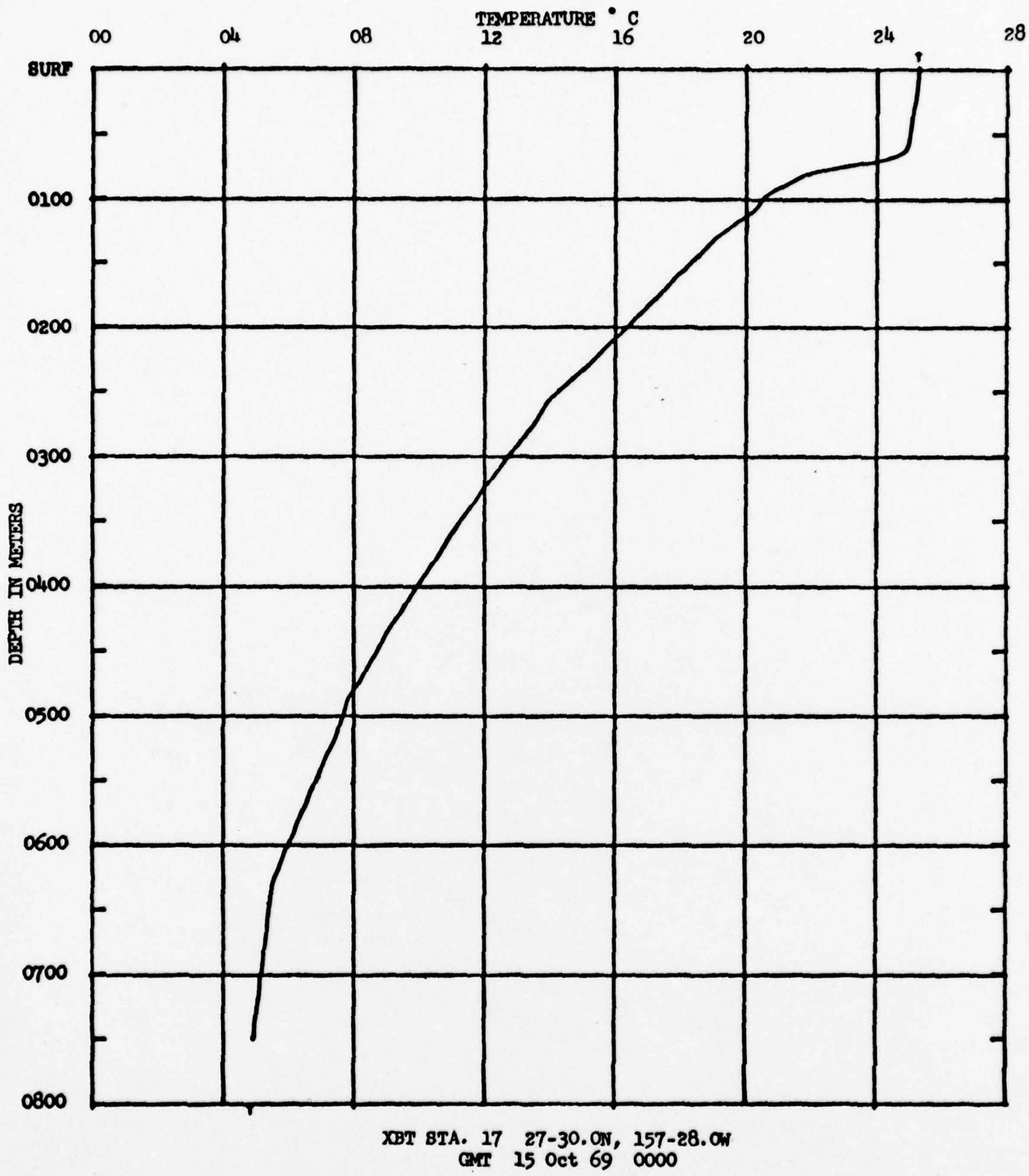


Fig. 19. XBT Profile, 15 October, 1969.

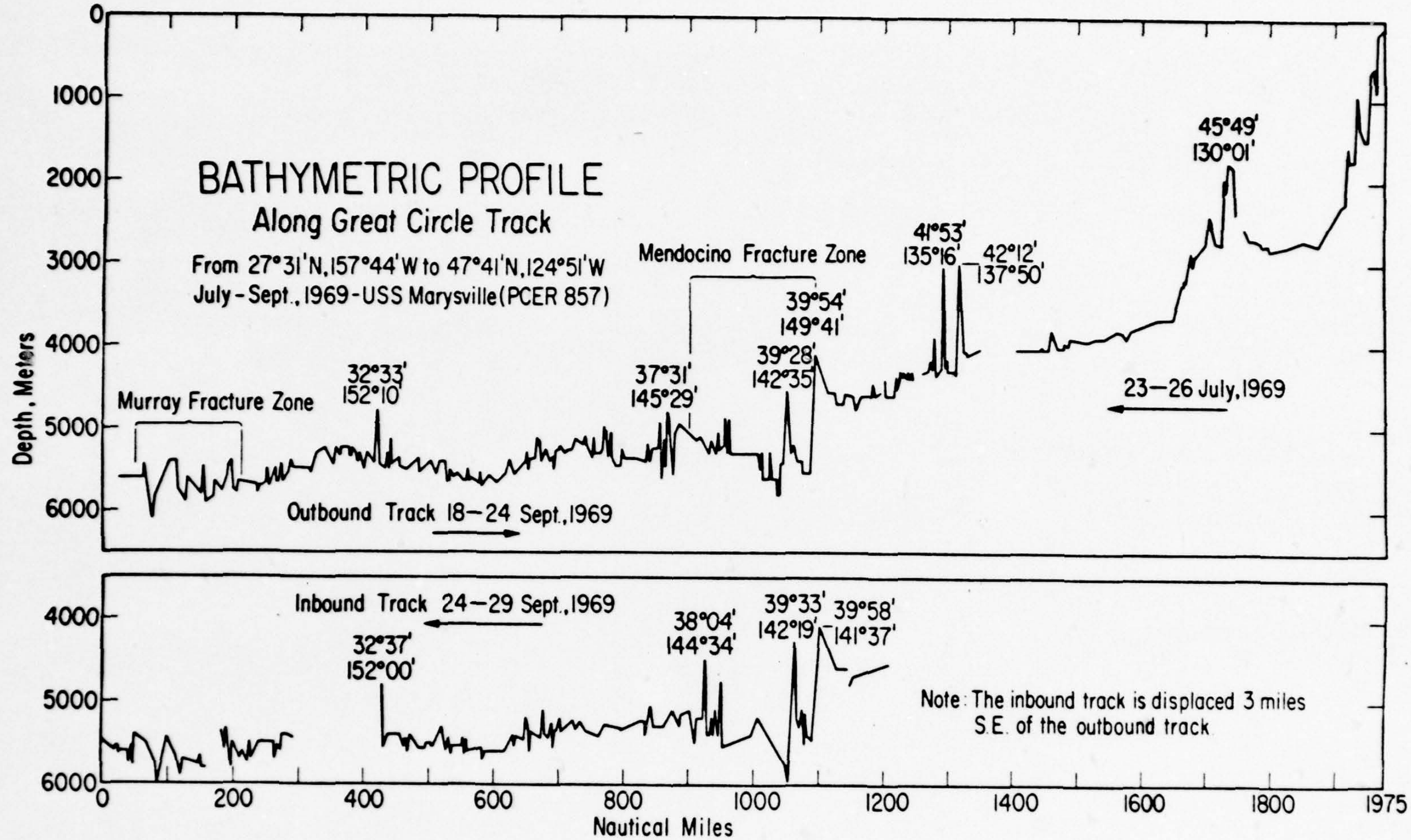


Fig. 20. Bathymetric Profile Seattle to Sea Spider Site.

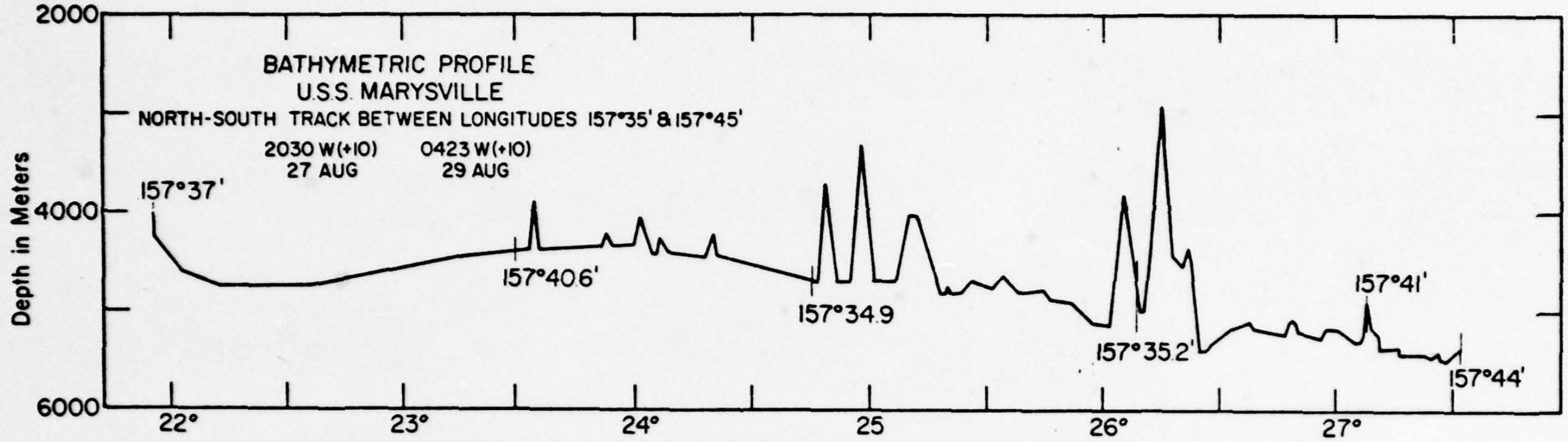


Fig. 21. Bathymetric Profile Oahu to Sea Spider Site, Eastern Track.

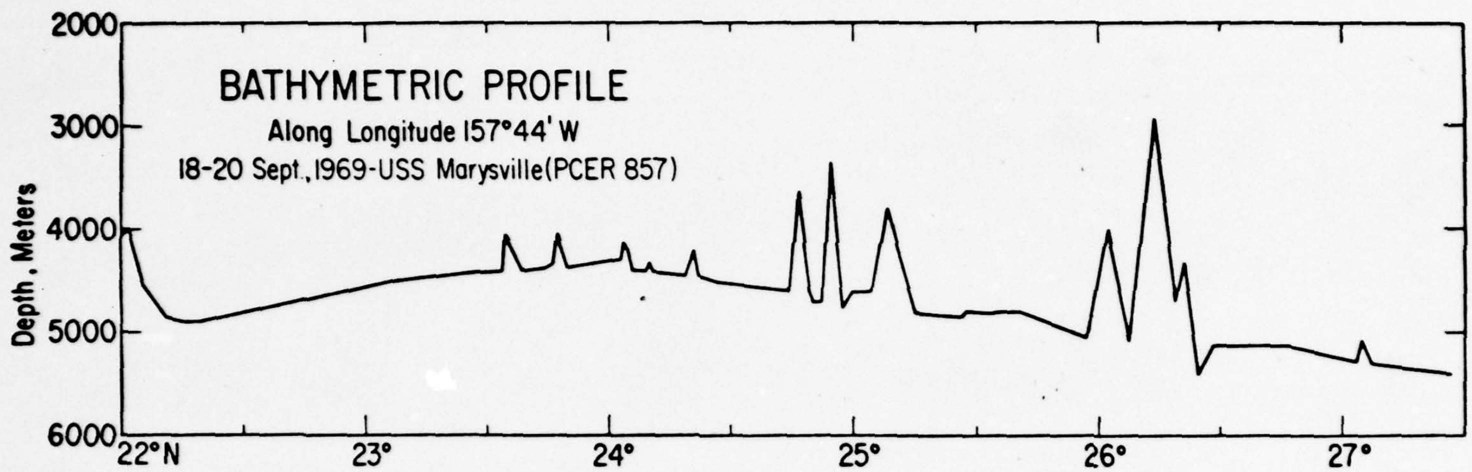


Fig. 22. Bathymetric Profile Oahu to Sea Spider Site, Central Track.

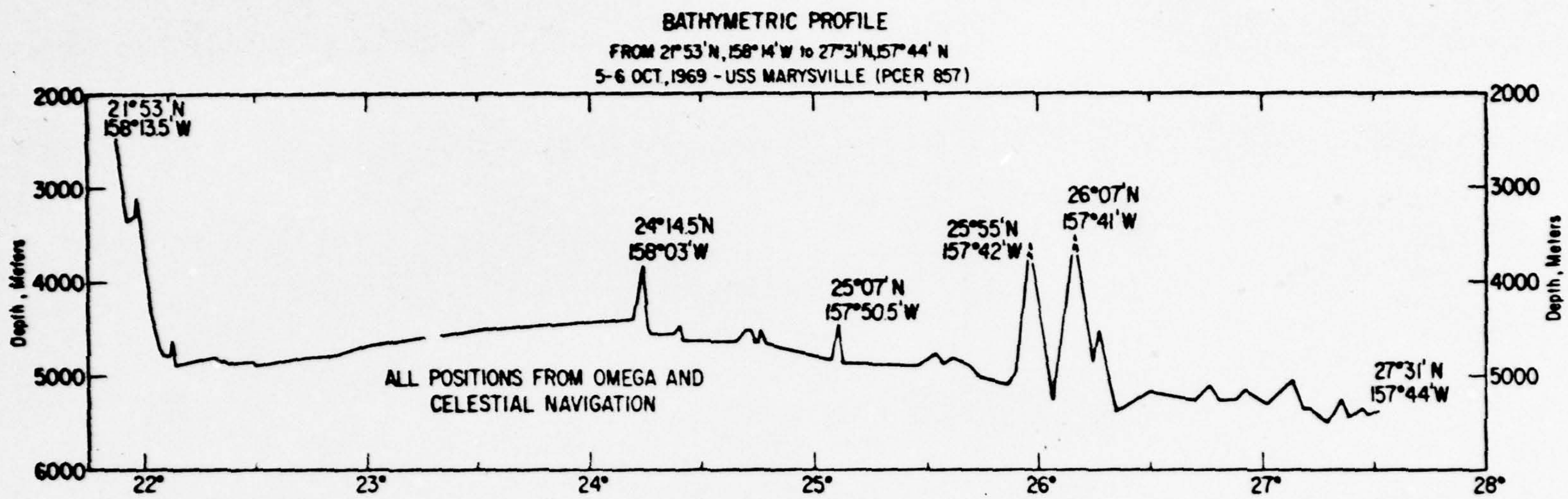


Fig. 23. Bathymetric Profile Oahu to Sea Spider Site, Western Track.

APPENDIX A

UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics

4 August, 1969

MEMO TO: Dr. G. P. Woollard

FROM: R. C. Latham

SUBJECT: Cruise Report, U.S.S. MARYSVILLE (PCER 857)

DATES: 22 July, 1969 to 1 August, 1969.

TRACK: Great Circle Course from Seattle to Honolulu

Objectives:

1. The primary objective was to obtain bathymetry from the 100 fathom curve over the Great Circle Course from 48°17'N, 122°37'W to 27°31.6'N, 157°44'W.

2. The secondary objective was to obtain environmental oceanographic data, temperature and sound velocity profiles, over the track.

Results:

1. Bathymetry was obtained only as far as 40°58'N, 140°00'W, or over only about the first 31% of the primary objective. Results show that bathymetry was obtained for the first 775 miles, less gaps totalling 107 miles or about 14% of the 775, from a track that was 2,003 miles in length. The failure to obtain bathymetry was caused by material failure which could not be repaired on board and is described later.

2. The secondary objective was achieved in full.

3. All bathymetric records have been turned in to ASWFORPAC.

Material:

The NUS velocimeter and associated wire and winch, RF Communications transceiver, Sprengnether clock and WWV receiver were shipped from Honolulu in May and installed in MARYSVILLE in San Diego in June. The Ocean Sonics transceiver and teletype equipment were ordered from the factory and were delivered to San Diego and installed in June. The crystals for the RF Communications and the two Alpine recorders were not received in San Diego until July and installation was made in MARYSVILLE just prior to her departure for Seattle on 15 July. Thus, the first chance to check the ability to obtain bathymetry was during the cruise from San Diego to Seattle. Electronics technician Gottesburen and Dr. John Northrop were on board for this portion of the cruise. They worked on the precision depth recording system, but were unable to get satisfactory results.

Accordingly they sent a message to the senior scientist, copy attached, which told of their inability to record depths in excess of 1,500 meters and their suspicion that the new Ocean Sonics transceiver was at fault. The senior scientist received this message by telephone just prior to reporting on board on Sunday evening, 20 July

Rough weather delayed MARYSVILLE arrival in Seattle from Saturday, 19 July to Sunday afternoon, 20 July. The ship delayed departure from 21 July to 22 July because of material problems. Tests Monday morning, 21 July, indicated that the Ocean Sonics equipment was not functioning properly. Monday was a holiday, Moon Day, but assistance was requested from Dr. Henderson, Director of the Applied Physics Laboratory, University of Washington, and two experts in bathymetric systems reported on board and made tests of the equipment. A letter of thanks has been prepared for your signature. No complete malfunction of equipment was found, but the tests indicated that full efficiency was not being obtained. The experts were hopeful, however, that calmer weather and operating experience with the equipment would enable results to be obtained.

Good weather prevailed throughout the cruise. Bathymetry was commenced on schedule at the 100 fathom curve and the deepest recorded depth of 4,700 meters was obtained just before the final breakdown, with bathymetry being recorded satisfactorily at maximum ship speed of about 13.8 knots. Three electronic technicians worked literally around the clock on the electronics of the bathymetric system until final failure about noon on 26 July. Most of the trouble is believed to lie in the Ocean Sonics transceiver. Whereas the overload light on this equipment could not be made to light in the beginning, it became progressively more cooperative until at the end it was lighted nearly continually. The first failure in bathymetry was traced to burned out components in the Ocean Sonics. These were replaced and subsequently they and others burned out and were replaced. The power side may be at fault, but lack of schematic wiring diagrams for many of the circuits prevented proper analysis. Action was taken at sea by radio to HIG to procure the missing schematics.

Two Alpine recorders are installed. Neither one was in excellent operating condition. One is now functional, however it requires adjustment and circuit balance for which schematic wiring diagrams were not on board. The other was used as a source of spare parts for the first and now requires a complete overhaul.

The NUS velocimeter system functioned essentially perfectly throughout. One or two minor parts replacements are indicated and minor modifications will be made to improve the format of data output. Calibration of temperature at the low end of the scale, 1.5 degrees Centigrade, will be made on arrival in port.

The level wind on both sides of the deck winch failed early in cruise with blowout of the same valve in each unit. This required level winding by hand power, necessitating an additional man on the winch throughout the cruise. The rough wind of cable

on the drum was responsible for mashing the cable and causing a short, due to the weight of 5,000 meters of wire and an instrument. The short is approximately 5,000 meters from the outboard end of a relatively new 7,500 meter cable. This will require cutting the cable at that point. After the short occurred, velocimeter casts were made using the cable on the other winch drum which limited depths to about 3,000 meters.

The RF Communications equipment could not be tested until towards the end of the cruise because the HIG set had not yet been converted to the new frequencies. Communications were established on 29 July and tested satisfactorily. The transmitter apparently failed on Channel 5 as the ship approached port although it was working properly on Channel 6.

The transmitter was not installed in the teletype equipment and consequently the environmental data messages were sent to FWC Pearl and FNWC Monterey by ship's radio.

Summary of Repairs Required:

1. Minor repairs to NUS counters and modification of data format.
2. Install transmitter in teletype equipment.
3. Test and repair transmitter on RF Communications Channel 5.
4. Test and repair Ocean Sonics transceiver.
5. Test and repair one Alpine recorder and overhaul the other.
6. Find the short circuit in the 1 HO cable, cut the cable and reconnect.
7. Repair the level wind pump on both sides of the winch.

Environmental Data:

XBT drops were made at 25-mile intervals between velocimeter drops which were made every 100 miles over the entire track from Cape Flattery to Oahu. XBTs showed 73% reliability with 66 successful drops out of 85 used. All velocimeter drops were successful. Preliminary information indicates that standard ocean tempertures which show a gradual decrease to a constant temperture of 1.5 degrees Centigrade in the north Pacific Ocean may have to be modified for this area to show a gradual decrease to 1.43 degrees and thereafter a rise to 1.5 degrees. The low end of the temperature scale of the NUS equipment must be calibrated before this observation is reported.

Navigational Accuracy:

Skies were overcast through 29 July resulting in very few celestial observations. Navigation was by LORAN. Occasionally, an

XBT station was missed completely because of inaccurate navigation. On one occasion the elapsed time for 100 miles between SVP stations indicated a speed of advance of 16.6 knots which is at least 2.5 knots in excess of the capability of the ship. However, acaurate fixes enabled adjustment of passed positions so that an overhaul position accuracy of two miles in the worst case and half a mile in the best case is believed to be reasonable.

MARYSVILLE:

Relations bwtween the ship's officers and crew and the scientific party were excellent at all times. Ship's personnel were all completely cooperative and never lost sight of the mission to support the scientific party in any way possible. Water hours were in force due to failure of one of the ship's two evaporaters. There were occasional minor delays due to engine problems. The ship's transmitter causes interference with the XBT recorder and the RF Communications receiver and must be shut down when the latter two units are in use. MARYSVILLE ship's radio was used to send environmental data since the transmitter for use with teletype was not yet installed.

Scientific Party:

All members of the scientific party were trained in all phases of data collection, except for the winch operator. Their performance was exemplary throughout. The scientific party consisted of:

Latham, R.	Scientist in Charge
Northrop, J.	Scientist
Wong, S.	Scientist
Mason, G.	Scientist
Ferguson, F.	Electronic Technician
Gottesburen, B.	Electronic Technician
Anderson, B.	Electronic Technician
Auld, D.	Winch Operator

R. C. Latham

R. C. Latham

NAVAL MESSAGE
OPNAV FORM 2110/20 (REV. 3-61) S/N 0107-705-4010

RELEASED BY	DRAFTED BY	PHONE EXT NR	PAGE	PAGES
R.L. POWERS, LT, USN			1 of	1
DATE: 19 JUL 69 / TOR/TOD	ROUTED BY: BLM	CHECKED BY		

MESSAGE NR	DATE/TIME GROUP (GCT)	PRECEDENCE	FLASH	EMERGENCY	OPERATIONAL IMMEDIATE	PRIORITY	ROUTINE	DEFERRED
152	19Ø5ØØZ JUL 69	ACTION				XXX		
		INFO				XXX		

FM: USS MARYSVILLE

TO: NSD SEATTLE // NAVCOMMSTA HONO

BT

UNCLAS

NSD SEATTLE, PASS TO CAPT. R.C. LATHAM USN (RET) IF HE CONTACTS CDO.

NAVCOMMSTA HONO PASS TO MR. THOMPSON, HAWAII INSTITUTE OF GEOPHYSICS

CORREA RD.

1. UNABLE TO RECORD IN DEPTHS GREATER THAN 15ØØ METERS.
2. SUSPECT OCEANSONIC TRANSCEIVER AT FAULT.
3. REQ ARRANGE TECH ASSIST

GOTZESBUREN SENDS.

BT

TOD

-NHB- 6453KHZ

CR Ø741Z/19JUL69

-T-P-19Ø5ØØZ JUL 69
-FM NUKU
-TO EIKR BLMU
HAIN
GR5Ø

DISTRIBUTION
(PAGE ONE ONLY)

ACT: Ø2

UNCLASSIFIED

DATE/TIME GROUP (GCT)

APPENDIX B

UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics

4 September, 1969

MEMO TO: Dr. G. P. Woollard

FROM: R. Budd

VIA: R. C. Latham

SUBJECT: Cruise Report, USS MARYSVILLE (PCER 857)

DATES: 27 August, 1969 to 4 September, 1969.

TRACK: To implantment site north along 157°40' meridian and steering various courses and making various speeds on station and during return to Pearl Harbor.

Objectives:

1. Obtain bathymetric profiles as required.
2. Make deep velocimeter cast at 1200 GMT (0200 W) daily (use Form HISTD 3167/43(7-68)).
3. Make XBT cast at 0200 W and 1400 W daily (use Form BATHY 3167/10-A (1-68)).
4. Record meteorological data at 0000, 0600, 1200 and 1800 GMT daily (use Form 3167/24(3-64)).
5. Sample sea surface temperatures by bucket thermometer every two hours (use Form 3167-A/(3-69)).
6. Transmit oceanographic data to Hawaii Institute of Geophysics (HIG) daily.
7. Detonate SUS charges and record time as directed.

Results:

1. Bathymetry was obtained along northern track from 22°N to 27°35'N. The track varied between 157°35' and 157°41' west longitude. The bathymetry was very good.

2. Only 3 deep velocimeter casts were made with NUS equipment since the ship's primary duties of surveillance and assistance in implantment precluded its immobilization for periods long enough to make casts at other times.

3. All XBT casts were made as directed.

4. Meterological data and sea surface temperatures were taken as scheduled.

5. A radio watch with OCC on voice circuit was maintained throughout the cruise. All Bathy and HISTD messages were sent via voice direct to OCC.

6. SUS charges were not detonated since this stage of implantment was never reached.

Material:

All equipment operated in an excellent manner. 8 XBT's were dropped without failing. NUS velocimeter was calibrated on 3 September, 1969 and showed no error in readings. Alpine gave excellent bottom profile record on all scales down to 5700 meters (deepest encountered).

The only failure was a burned-out blower motor for the output stage tube of the RF 102 1 kw amplifier. Repairs were made by making small modification to a ship's bulkhead fan motor and installing it in place of the burned out motor. Since this modified installation was only about 60% efficient in cooling, the amplifier was only energized when needed for transmission. This motor should be replaced during refit period.

Scientific Party:

All members of the scientific party were trained in all phases of data collection, except for the winch operator. Their performance was exemplary throughout. The scientifc party consisted of:

Budd, Romondt	Senior Scientist
Zachariadis, Robin G.	Scientist
Wong, Raymond W. C.	Scientist
Patnode, Paul J.	Scientist
Reniere, Robert B.	Electronics Technician
Ryan, John	Technician (winch operator)

In addition there were four employees of IEC (Interstate Electronics Corp.):

Mr. Debord, M. J.
Mr. Witmer, D.
Mr. Wilke, C.
Mr. White, H.

Also there was one from ACDRL, Dr. R. J. Rutten, M.D. and a CPO from NavFac, rad-safe officer, J. G. Schnable, CECS.

Relations between the ship's officers and crew, the contractors' personnel and the scientific party were excellent at all times.

LOG OF SSOB
PHASE II PARKA II

USS MARYSVILLE

27 August, 1306: Underway in company with USNS SANDS and R/V RIGBUILDER for station. Following is track for bathymetric profile.

27:2000 W	Posit	21°55'N 157°37'W
	Course	357.5 speed 10.8 knots.
28:0800 W	Posit	23°59'N 157°40.6'W
	Course	003· Speed 11.0 knots.
28:1200 W	Posit	24°42.5'N 157°34.9'W
	Course from 27:2000 to 28:1200 359.5 SOA speed 10.86 knots.	
28:2000 W	Posit	26°08'N 157°35.2'W
	Course	355 speed 10 knots.
29:0200 W	Posit	27°08.0'N 157°41'W
29:0423 W	Posit	27°31.8'N) 157°44'W) On Station
29:0424 W	Arrived on station. Commenced steering various courses and making various speeds while investigating contacts, furnishing boat service and radio guard. Made 8 XBT drops on schedule.	
29:0800 W	Shifted from channel 6 to channel 5 on voice circuit in order to establish good voice communication with Oahu.	
Sat., 30 August	(Forenoon) Subsurface buoy and surface buoy launched. Commenced laying first leg in N.E. direction. Sea state 2 - 3.	
Sat., 30 August	2130 RIGBUILDER secured implanting operation for the night.	
Sun., 31 August	0100 W Subsurface buoy and surface buoy broke loose from reaction buoy and drifted into marker buoy at about 0200 W fouling it with a 1/2 turn of cable.	
Sun., 31 August	0600 RIGBUILDER went ahead and fouled cable in screws.	

Sunday morning through Monday afternoon 1 September.

1. Divers cut loose cable from screws.

2. Cut marker buoy cable--marker buoy adrift.
3. Retrieved cut cable from N.E. leg and removed floats.
4. Surface buoy was taken aboard.
5. Subsurface was taken in tow.

Mon., 1 Sept.	1000 Made deep velocimeter drop at 6000 yards south of RIGBUILDER.
Mon., 1 Sept.	1100 Terminated drop and brought probe aboard so that MARYSVILLE could maneuver to lower boat for RIGBUILDER.
Mon., 1 Sept.	1230 Made deep velocimeter drop to 4000 meters with excellent results.
Mon., 1 Sept.	1430 RIGBUILDER underway for Pearl Harbor towing subsurface buoy. Course about 185°T to approach from leeward side of Oahu. SOA 7 - 8 knots. MARYSVILLE in company steering various courses and making various speeds, keeping station on RIGBUILDER.
Tues., 2 Sept.	Ship conducted general drills. At 1000 W stopped and made NUS (deep velocimeter) drop at 25°16'N and 158°10'W for training purposes.
Wed., 3 Sept.	Underway as before
Thurs., 4 Sept.	0830 Arrived at Pearl Harbor.

Data concerning RIGBUILDER is from radio intercepts and discussion with contractor's employees on board.

APPENDIX C

UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822

30 September, 1969

MEMO TO: Dr. G. P. Woollard

VIA: R. C. Latham

FROM: R. Budd

SUBJECT: Cruise Report, USS MARYSVILLE, 18 - 29 September, 1969.

Objectives:

1. Obtain bathymetric profiles over entire track on both outbound and return voyage.

2. Make XBT casts every 15 miles from 22°N to 27°30'N, also from 27°30' to 22°N on return leg every 12 hours at other parts of track.

3. Obtain sea surface temperatures by bucket thermometer as required.

4. Record meteorological data every six hours.

5. Transmit required oceanographic data to Fleet Weather Center Pearl via HIG Electronic or Navy Radio circuit.

6. Make NUS casts as time permits.

Track:

From Pearl Harbor. Proceed via Molokai Channel to 22°N, 157°44'W, thence north to 27°31'N, 157°44'W and thence by great circle track to 40°58'N, 140°00'W. Return on a parallel track 3 nm to southeast of outbound great circle track to a position 500 miles from latitude 27°31'N longitude 157°44'W thence by great circle to that position.

Results:

The Ship - This cruise provided a good problem in logistics. The distance to be covered had to be balanced with time allowed, fuel consumed at high speeds and water made. These inter-related factors were dominant in all

decisions. The C. O. displayed excellent judgement in fulfilling his responsibilities in this matter. Officers and crew of the USS MARYSVILLE gave outstanding support to the scientific achievement.

Bathymetry - The PDR system had been giving very good results during the last cruise and was functioning normally when secured upon entering port. In preparation for getting underway on this cruise the system was tested at 0700 W on 18 September. No signal could be produced. Investigation revealed that the transducer had fallen off the supporting column. Sailing was delayed until all possibilities for replacement of a transducer were investigated. A suitable 12KC, 1KW transducer was located and requistioned from the ship yard. 9" bolts were machined from 5/8" monel stock by the Outside Machine Shop on an emergency basis. The transducer was installed by University and Ships' personnel working in the sea chest while the ship was proceeding to the first station. The installation without any blue prints or instructions was necessarily an experimental jury rig. The job was completed, sea chest buttoned up, gate valve opened and column lowered to within about 3 feet of full extension. The results were beyond all expectations. Excellent traces were produced at 11.5 knots and 5,500 meters. Good results were obtained at 12.5 and 13 knots, the necessary speed over much of the track. At 24/0800 W -- after reversing the track, the transducer was rigged in and the sea chest opened for inspection while an NUS drop was being made to 4200 meters. The transducer was found to be tight to the column. Upon getting underway and resuming bathymetric operations, the signal did not appear as good as before inspection. This signal was improved by adjusting the extension of the column to obtain minimum vibration and turbulence. Under different combinations of speed, course and sea conditions, there is an optimum position at which the transducer produces the best signal with a minimum of background noise.

At 27/2000 W with about 400 miles to go on the great circle track, the signal was lost in the vicinity of 6000 meters. Adjustments showed overload and a short circuit. Upon going forward to adjust the extension of the transducer column, it was found that the column was vibrating violently. It was rigged in and inspected. The transducer had shaken loose and was lost in spite of being secured with lock washers on the nuts and giving no indication of loosening on the outbound trip.

The towed transducer was streamed from the port quarter at about 100 ft. astern of the ship and 50 ft. below the surface. It gave very good results at speeds up to 12.5 knots but failed to give signals in excess of 6000 meters which only occurred over a few miles on this portion of the track.

XBT System - 60 XBT's were dropped with 6 failures. Horizontal temperature profiles were plotted. No unusual conditions were observed. The thermal front was apparently above the 27°30'N limit of the profiles. The profiles on the outbound and the inbound tracks were almost identical.

NUS System - One drop to 4200 meters in 4550 meters of water was made. It showed a temperature inversion from 1.45 to 1.49 between 3600 meters and 4200 meters.

Omega Navigation System - Performance was very good. Positions were consistent after lane was established and readings taken every hour. After

about 2800 miles steaming we ended with the buoy, as predicted, dead ahead. However, due to problems in steering we were 3 to 5 miles off the track on several occasions. The ship should have an automatic pilot for better results. A better system of lane numbering on the Omega is needed also.

Records and Messages:

1. 60 XBT profile records were made and messages sent by Navy radio circuit. 2 horizontal temperature profiles were plotted from 22° to 27°30'N.

2. One NUS vertical profile, digital print out, and punched paper tape record was made and HISTD message sent.

3. 9 rolls (sections) of bathymetric traces were obtained. 2730 miles of bathymetric profiles for track north to buoy and both outbound and inbound tracks from and to buoy were recorded.

4. Omega readings and positions were recorded each hour for 11 days.

5. Weather and sea surface temperature readings were recorded as planned.

Significant Findings:

1. A 1600 meter high ridge at about 1050 miles from buoy and a sudden rise from 5550 meters depth to 4100 meters at about 1100 miles from buoy (probably extension of Medocino fraction zone) were noted.

2. Bathymetry response from transducer on column extending from bottom of ship is very sensitive to position of column under various conditions of speed and sea.

3. Towed transducer operates well from under wake at speeds up to 12 knots and depth to about 5600 meters.

Scientific Party:

Romondt Budd,	Senior Scientist
Robin G. Zachariadis,	Scientist
Robert B. Reniere	Electronics Technician
Donald E. Auld,	Technician (winch operator)

APPENDIX D

UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822

17 October, 1969

MEMO TO: Dr. G. P. Woollard

VIA: R. C. Latham

FROM: R. Budd

SUBJECT: Cruise Report, USS MARYSVILLE, 4 - 17 October, 1969.

Objectives:

1. Obtain bathymetric profiles enroute to implantment area.
2. Make XBT casts at 0000Z and 1200Z daily.
3. Obtain sea surface temperatures by bucket thermometer as required.
4. Record meteorological data every six hours.
5. Transmit required oceanographic data to Officer conducting exercise.
6. Make NUS casts at 1200Z daily provided the ship's primary duties of surveillance and assistance in implantment make this possible.

Track:

Proceeded from Pearl Harbor to implantment area, operated in this area and returned to Pearl Harbor.

Results:

The Ship - During this cruise the primary duty of the ship was surveillance and assistance to the ships engaged in the emplacement of the buoy. A secondary duty was to gather oceanographic data and assist in certain tests after the buoy was implanted. Since the entire time in the area was spent in support of implantment and recovery of the buoy, no opportunity was available for aquiring scientific data other than the planned XBT traces, surface temperature readings and meteorological data. A bathymetric profile was made enroute to the area along a relatively direct track of 005° true.

The attempt to implant the Sea Spider buoy was not successful and the cruise, although not classed as successful from a scientific or technical point of view, was very interesting and informative. It served as a reminder of man's limitations in dealing with the powers of the ocean.

Aside from a couple of days of rough weather during the passing of a cold front, the weather was very pleasant. Seas were relatively small, but large swells were experienced from the storms passing north of us.

Accomodations and food were excellent and cooperation between the scientific and ships personnel continued on a superior level.

Bathymetry - A good bathymetric profile by Ocean Sonics Transceiver and Alpine Precision Echo Sounder Recorder was obtained between Oahu and the implantment area. On the 12th and 13th of October a search was conducted for the broken cable legs with their attached electronic and buoyancy gear. This proved impractical.

XBT System - 22 XBT probes were dropped with 5 failures.

NUS System - This system was tested shortly after arrival in the area and it was found that short circuits existed in the first 800 meters of wire adjacent to the slip-rings. This was cut off leaving 4,200 meters of wire on this drum. The cable was then connected and prepared for use. However it was never used because the primary duties of the ship precluded its immobility for periods of about one hour which would have been required to retrieve the probe from its deepest position.

Radio - The RFD2B SSB voice radio performed satisfactorily until 13 October when the receiver commenced to fade and finally became dead. The transmitter was functioning satisfactorily at this time. The audio assembly was removed for inspection for loose connections. None were found and the assembly was replaced. Upon rechecking, it was found that the receiver now functioned properly but that the transmitter was not putting out a signal. The output meter showed a negative deflection. After disconnecting the automatic load control circuit, the carrier was again made to oscillate. Instructions were then received from HIG on how to manually tune the set. This was done but shortly afterward the transmitter was out of commission again. Since there was a lack of knowledge as to the way to find the trouble and since spares were not available on board in case something was found to be burned out, it was decided to resort to the use of the ship's AN/URC35 Transceiver. This was then tuned to channel 5 and used for the remaining 3 days of the cruise.

Omega Navigation - All four channels on the Omega receiver were set to record navigational data in hyperbolic mode. It was found that Omega fixes were consistently offset from radar and celestial fixes, but that the amount and direction of offset remained constant to the degree that a plot of the Omega position ran parallel to ship's D.R. plot and reflected changes in course and speed. Hence the Omega positions were used as additional information, giving course and speed made good, thus improving the accuracy of the ship's D.R. plot. This was especially useful during periods when over-cast conditions precluded taking celestial sights, and in areas where Loran was erratic.

An HIG lane numbering system has been derived for use with Omega at 13.6 kc and was used on this cruise with complete success.

With practice it was possible for the navigators in the scientific party to process an Omega fix and pass it to the bridge within 5 minutes of commencing the observations.

Records and Messages:

1. 17 XBT profile records were made and bathy messages sent by voice radio circuit.

2. 3 rolls (sections) of bathymetric traces were obtained. Bathymetric profiles for the track north to the buoy were recorded and plotted.

3. Omega readings and positions were recorded each hour during transit to operating area.

4. Weather and sea surface temperature readings were recorded as planned.

Scientific Party:

Romondt Budd,	Senior Scientist
Robin G. Zachariadis	Scientist
Arthur Hull	Scientist
Bruce Gottesburen	Electronics Technician
John Ryan	Technician (winch operator)

APPENDIX E

10 September, 1969.

Temperature Inversion Analysis

On MARYSVILLE cruise from Seattle to Honolulu during the period 22 July - 1 August, NUS temperature and velocimeter profiles were obtained at 100 mile intervals. Station number one was close to the Washington coast off Cape Flettery, station number two was 100 miles further seaward along the great circle course, station number three was 100 miles further seaward, etc. As the water depth increased with distance from the coastline, the probe was lowered to progressively increasing depth. At stations 11, 12 and 13 when depths of 4450m, 4470m and 4960m were successively attained, temperature inversions amounting to 0.03°C, 0.04°C and 0.08°C were noted. The minimums appeared at depths of 3700m, 3700m and 3810m respectively with progressively increasing temperatures to the maximum depth reached. A break in the cable following station 13 limited depths thereafter to about 4200 meters and prevented further definite confirmation of the inversions noted, however, later temperature profiles indicated that a minimum temperature had been reached at about 3800m and that temperatures increased slightly with increase in depth below that point. Instrument calibration at ambient pressure upon return to port showed less than 0.01°C temperature error over the range from 1.24°C to 25.85°C. The NUS specifications show a pressure effect of less than 0.01°C at 10,000 psi.

Examination of data obtained with the WHOI IES in February 1969 when depths of 4280m and 4114m were reached shows a temperature inversion of 0.01°C when minimums were reached at about 4000m. Data obtained by NUS velocimeter from

MIKIMIKI in August and September 1968 reveals that 23 stations showed a temperature inversion with minimums occurring between depths of 3690m and 4260m. The amount of inversion varied from 0.01°C to 0.09°C with the greatest inversion occurring at the maximum depth reached (5390m). An analysis of NODC archival data taken from deep casts by nansen bottle in the western North Pacific gave strong evidence of similar inversions. Fifty stations were examined at random. Data are shown for standard depths at 3,000m, 3,500m, 4,000m, 4,500m, 5,000m and deepest depth reached. Minimum temperatures appeared zero times at 3,000m, 20 times at 3,500m, 29 times at 4,000m, once at 4,500m and never at 5,000m. The maximum amount of inversion shown was 0.33°C from a minimum of 1.48 at 4,000m to a maximum of 1.81 at 5,483m. In all cases but two the increase in temperature below the depth at which the minimum was reached was progressive to the greatest depth reported.

Defant (1961) has stated that "The vertical temperature differences in the very deep layer of the ocean stratosphere are small. Here also the distribution is almost everywhere anothermic;......Departures from this anothermic distribution are found only in the western Atlantic (Brazilian and Argentinian basins) and in the south-western Indian Ocean where at a depth of 1300-1600m there is a very weakly marked temperature inversion, a phenomenon of particular importance for the oceanic circulation of these oceanic spaces." Also, "At very great depths, below about 4500m, especially in the more or less extended deep-sea basins, the vertical distribution approaches the adiabatic......" Also, "While a steady decrease in temperature with increasing depth is characteristic for the open oceans,......"

Dietrich (1957) has stated, "In practice, it has proved convenient to base the measured temperature on normal pressure. A pressure at the sea surface, p = 0, has been chosen, and the temperature that a water sample attains

when lifted adiabatically to the sea surface is called potential temperature t_p. Therefore $t_p = t_m - \Delta t_{ad}$ where t_m is the observed temperature at the corresponding depth, and Δt_{ad} is the adiabatic temperature effect. B. Helland-Hansen, who defined this expression of potential ocean temperature, also computed extensive tables in 1930......This series simultaneously represents the temperature series of the deepest part of the oceans. The measured temperature $t_m = 2.48°$ at 10,000m depth corresponds to $t_p = 1.17°$ in this case. The adiabatic effect causes a temperature increase of 1.31°." Also, "In oceanography the potential temperature assumes special significance in the three following cases: (1) If the spreading of water masses, which occurs over considerable layers, is deduced from temperature observations. Based on such a deduction, G. Wüst, using the distribution of the potential temperature, was able to show the spreading of the bottom water in all three oceans. (2) If the so-called sill depth......(3) Potential temperature becomes important when dealing with the stability of oceanic stratification at greater depths and with the heat flux from the interior of the earth. The temperature increase, which has been observed in several oceanic areas in the vicinity of the ocean floor, could always be explained by adiabatic effects and not by heat flux through the ocean bottom. This does not mean that no heat flux through the ocean floor exists. However, the adiabatic stratification indicates convection, which is maintained by the heating of the bottom water, does not permit an unstable stratification."

Knauss (1962) has stated "The deep water of the North Pacific has a temperature minimum at about 3500 meters, below which the temperature increases. At 3500 meters the water in the North Pacific is colder than that in the South Pacific at the same depth. The coldest water (1.45°C) is still to be found south of the Aleutian Islands. Water of less than 1.50°C, however, can be

found in the central North Pacific basin. Although the details of this flow are not clear, it is difficult to see any other explanation than that this water is rising from below and being cooled adiabatically. The salinity of the Pacific deep water is less in the North Pacific than in the South Pacific, and this decrease is caused by vertical mixing with the warmer, less saline water from above. Without upwelling, therefore, the water at 3500 meters would be expected to be warmer in the North Pacific than in the South Pacific. The fact that it is colder can only be accounted for by water coming up from below." (JGR Vol. 67, Sept. 1962, Number 10, Page 3946).

G. Bodvarsson et. al. (1967) have shown a rather high heat flow of 3 μcal/cm^2 sec through the bottom off the Oregon coast. (JGR Vol. 72, Number 10, May 15, 1967, Page 2693).

The magnitude of the effect of the temperature inversion on the observed sound velocity compared to the effect of the earth's curvature on the velocity of long range sound transmission at depth can be seen from the following calculation:

The effective velocity of sound including the curvature of the earth is given by

$v_{eff} = v_o \left(1 + \frac{z}{a}\right)$ where a = radius of the earth

(v_{eff} = effective velocity - includes correction for curvature of earth and v_o = velocity measured at depth z.)

or

$$\frac{v_{eff} - v_o}{z} = \frac{v_o}{a} = \frac{1500 \text{ m/sec}}{6.37 \times 10^6 \text{m}} = .2355 \times 10^{-3} \text{ sec}^{-1}$$

The observed gradient of the temperature inversion due to the adiabatic effect is given by

$$\frac{\Delta t_{ad}}{z_d - z_a} = \frac{.09}{5390 - 3740} = .545 \times 10^{-4} \text{ °C/m}$$

(where Δt_{ad} is the temperature difference between depth z_d and z_a.)
Using the first term of Wilson's equation we note that $\Delta v = 4.5721$ T.
Thus

$$(4.5721 \text{ m sec}^{-1}\ {}^\circ\text{C}^{-1}) \times .545 \times 10^{-4}\ {}^\circ\text{C m}^{-1} = .249 \times 10^{-3} \text{ sec}^{-1}$$

Thus the theoretical temperature inversion effect is the same order of magnitude as the effective velocity allowing for earth curvature, and in the Pacific is slightly larger than the velocity-depth correction due to the earth's curvature.

From the above review of a partial list of references concerning temperature inversions in the deep, open ocean it appears that such inversions have been noted and documented in the North Pacific Ocean previously. However, the reported details of the observations are of recent origin and are generally not well known. Further investigations as to extent, possible relationship to areas of high heat flux and effects on long-range transmission of underwater sound appear to be of interest.

Summary

A definite temperature inversion has been clearly shown to exist in the North Pacific along longitude 157°50'W between the Hawaiian Islands and the Aleutian Islands and along the great circle course between Lat. 27°30'N Long. 157°44'W and Lat. 48°17'N Long. 122°37'W. The temperature minimum is found at about 3800 meters and the temperature increases progressively with increasing depth to at least 5400 meters, the greatest depth measured. The amount of increase from 3740 meters to 5390 meters was measured as 0.09°C. It is probable that the temperature increase continues to the bottom.

The locations of the stations which gave positive evidence of a temperature inversion are shown in Figure 4.

Deep temperature profiles should continue to be obtained in the broad

ocean area between the Hawaiian Islands and the Aleutian Islands in order to document the extent of the temperature inversions present.

The temperature inversions present in the North Pacific are of interest in formulating models for the prediction of the long-range transmission of underwater sound.

APPENDIX F

First Inspection of Current Measurememts Made at the "Sea Spider" Site

(Prepared by Dr. K. Wyrtki)

A string of four current meters located at 35, 150, 300, and 1000-meter depths was operated near the "Sea Spider" site from September 18 to 24. All four current meters obtained good records, although the instrument at 1000 meters failed after three days. See Appendix G, Cruise Report R/V TOWNSEND CROMWELL, for reason.

An inspection of the analog records as processed by Geodyne Corporation shows the following situation:

During the entire time the current at 35 meters was flowing in directions near 300°, with speeds of 0.6 to 0.8 knots. The indications of the vane are very erratic and most probably this was due to wave action on the upper part of the mooring. The inclinometer in that current meter showed frequent inclinations of between 5° and 10°, occasionally up to 15°, but never 20° or more.

At the 150-meter depth the indication of the vane was much more stable and the direction of flow was around 320° with speeds near 0.4 knots during the entire period. Inclinometer indications are only occasionally as high as 5° and 7°. It is rémarkable that at this depth and at the lower depths, the compass in the instruments showed a very constant reading during the entire time, indicating that the mooring was not rotating around its own axis. In contrast to the steady reading of the compass, the indication of the vane was much more variable.

At the depth of 300 meters the current was again in a direction of about 300° with rather little variation. Speeds ranged from 0.3 to 0.4 knots. At

both the 300-meter and the 150-meter levels a weak indication of a 24-hour tide is found. At 1000 meters the current was recorded only during the first three days. The direction is 360° but the speed is higher than in the water above, being about 0.6 knots.

The measurements indicate that during six days of rather calm weather with wind speeds only occassionally reaching 15 knots, the flow near the "Sea Spider" site was very stable and showed little or no variation; no high speeds were encountered. This result is in complete agreement with our previous assessment of the conditions that would prevail at the site.

APPENDIX G

ANALYSIS OF CORES TAKEN BY USNS SANDS SEA SPIDER SITE

by

Pow-foong Fan,
John Southworth,
Maury Morgenstein

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1. INTRODUCTION

Three boomerang cores (782, 785, and 786 in Fig. 1) collected by the USNS SANDS north of the Hawaiian Islands were delivered to the Hawaii Institute of Geophysics on 13 August 1969. The subject of the report is an analysis of these cores using standard procedures at the Core Analysis Laboratory of the Hawaii Institute of Geophysics. Included are measurements or samplings for the following:

1. Megascopic and microscopic descriptions
2. Physical properties
3. Sediment sound velocity
4. Shear Strength
5. X-ray diffraction analysis

Figure 2 indicates the segments sampled for each type of analysis.

2. MEGASCOPIC AND MICROSCOPIC DESCRIPTIONS

A. General

The cores are homogeneous pelagic muds which are limited in gross sedimentological structure. The sediments consist mostly of silty clay. In those samples having a higher silt content, there are traces of fine sand. Mineralogically the core material is consistent with normal pelagic sedimentation and bottom current deposition. Less than 1% of the sediment consists of allogenic constituents of which the light mineral fraction dominates. Quartz grains are more prevalent than feldspar; and the former is usually greater in size. The coarse silt sized particles contain calcic plagioclase, and these are consistent with the Pacific interbasin volcanic mineral suites.

The authigenic constituents are by far the most prevalent components of the sediments. They consist mainly of finely disseminated silt sized palogonite

grains which have undergone all stages of hydration. Second in abundance is manganese micronodules which are the largest component of the inorganic constituents. The clay spherules present contain palogonite centers and rims of highly concentrated iron oxide-hydrates. The organic fraction is much more limited than the inorganic, and consists mainly of siliceous bioclastics (reworked radilaria) which comprise about 5% of the silt fraction. Occasional phosphatic bioclastic debris is also encountered.

3. AN INTERPRETATION OF MARINE SEDIMENT DEPOSITION FROM A STUDY OF MANGANESE MICRONODULES

Until recently sedimentologists have not concerned themselves with studies of deep-sea "red clay" sediments. These sediments have been generally described as geographical deposits whose physical properties sustain certain sound velocities. The origin and mode of marine sediment transport have not been given much consideration. It is important to underline the concept that in order to fully describe these sediments in the marine environment it is necessary to derive their origin.

One component in pelagic sediments, manganese micronodules, contributes information concerning the origin of those sediments. The relationship of micronodules to sedimentary diagenesis and transport have been clearly established by Morgenstein and Felsher (report in preparation). Briefly these relationships are as follows:

(1) Manganese micronodules are authigenic products of a combined chemical reaction between elements in the sea-water and those at the sediment surface. These micronodules do not have typical seed centers as do the manganese mega-nodules, and thus their shape is dependent upon differential growth at the sediment water interfaces, rather than determined by the shape of their centers. A typical growth shape for manganese micronodules at the sediment

water interface is an eliptical habit. The largest growth radius is found in the plane of the sediment-water interface, and the smallest growth radius is found perpendicular or inclined to the sediment surface. The micronodules which are in growth position close to one another, commonly cement themselves together in a "grape vine cluster". Usually these clusters are not greater than three or four micronodules. After clustering, growth continues in a normal manner and the resultant shape configuration is determined by the overall shape of the cluster and its orientation at the sediment-water interface.

(2) Manganese micronodules also occur as sedimentary grains, and as such, are commonly eroded from seamount formation sites, transported by bottom currents and deposited in an area where manganese authigenesis does not necessarily exist. The shape configuration of transported micronodules is spherical. Commonly, the surface of the nodules are jagged and show impact erosion features.

The three cores were studied using manganese-micronodule shape as a guide for pelagic sedimentation versus deposition by bottom current transport. Figures 3, 4, and 5 show the scattering of micronodular shape in each of the entire cores. Figures 6, 7, and 8 show the relationship between nodular shape and core depth.

Core 782 shows that the recent near surface sediments have been transported and deposited. With increased depth to about 45 centimeters there is some indication of normal pelagic sediments and diagenesis.

Core 785 also shows the near surface material was derived by recent sediment transport and deposition. At about 40 centimeters and, again at 70 centimeters depth, diagenesis is apparent.

Core 786 shows a reversed relationship with the oldest and youngest sediments both undergoing a process of diagenesis. The middle of the core suggests a period of bottom current transport and deposition.

The periods of diagenesis indicate a reduction in the sediment accumulation rate. Normal pelagic sedimentation may have been slow, but probably continuous and is the most probable source for the clays and silts of the sediments.

The periods of bottom sediment transport indicate rapid rates of sedimentation and point towards the reworking of sediments as the major supply of material deposited in topographic sediment traps. These traps may be small features not easily recognized by seismic profiling, or may be large features as the major oceanic basins, trenches or flat lying topography in regions of abyssal hills and seamounts.

In conclusion, these three cores show evidence of differential sediment accumulation rates over an area of rather restricted areal extent.

The slow rate is characterized by pelagic settling and possibly short periods of non-deposition. The faster rate indicates bottom current transport and/or minor turbidity currents. It would be expected that those areas which have marked irregular shaped micronodules may form sedimentary manganese layers at periods of non-deposition. They thus represent key stratigraphic horizons formed during periods of minimum sedimentation. These horizons are normally good sub-bottom reflectors and can be stratigraphically correlated over large areas. The cores studied do not show any major stratigraphic horizons because the periods of slow depositions appear to have been short. It is probable that the sporadic periods of rapid sedimentary deposition indicated were brought about by bottom current transport of debris.

4. X-RAY DIFFRACTION ANALYSIS

The minerals distribution of 36 samples (12 samples from each core, see Fig. 2) were determined by X-ray diffraction method. They showed a uni-

form assemblage (Figs. 9, 10 and 11). The minerals present in these cores are listed in order of decreasing abundance: Quartz, illite, chlorite and plagioclase. Quartz and illite are eolian origin. They are probably the result of fallout of dust from the high altitude jet stream (Rexard Goldberg, 1958). Chlorite could have been colian origin or it may be brought in by currents. Plagioclase is probably derived from local sumbarine eruption.

In summary, the physical and mineralogical properties indicate that the sediments are typical pelagic deposits.

5. RESULTS ON PHYSICAL PROPERTIES TESTS

Moisture, bulk density, specific gravity, porosity and void ratio were determined by calculations on wet and dry weights of a volumetric sample. As is customary in most marine sediment physical properties calculation, it was assumed that the sediment was completely saturated (i.e. all pore space is water-filled). The observed data logs for each core are attached as Tables 1, 2 and 3. Figure 4 shows a composite of physical properties for the three cores. Owing to possible error in the volume determination (e.g. bubbles, cracks in sediment, etc.) more variation is seen in all parameters except moisture content, which is independent of volume.

A. Moisture Content

Moisture was determined as the dry weight percentage of wet weight, i.e. moisture content (%) = dry weight ÷ wet weight x 100.

This varied about 4% (46.8% - 50.8%) for all of the three cores.

B. Bulk Density, β

Bulk density is a measure of the total density of the sediment mass, i.e. --- β(g/cc) = wet weight/wet volume.

The bulk density ranged from 1.35 - 1.54 g/cc.

Core #	Average Values Bulk Density
782	1.47
785	1.43
786	1.46

C. Porosity, η

Porosity is the relative amount of sediment mass which is composed of water. This calculation was made using method of Sutton et. al. (1957).

$$\eta = \left[(W-D)/W\right] \rho/\rho W$$

W = wet weight

D = dry weight

ρ = density of wet samples

ρW = density of water

The porosity ranged from 63.9 - 76.3%.

Core #	Average Porosity, %
782	71.6
785	69.1
786	70.6

D. Specific Gravity, G

The ratio of the weight in air of a given volume of sediment solids to its weight in water is the specific gravity. By these measurements the range was found to be 2.1 to 3.3. The average values were as follows:

Core #	Specifc Gravity
782	2.7
785	2.4
786	2.6

E. Void Ratio

The ratio of the void space volume to the volume of solids is the dimensionless void ratio. In these cores it ranged from 1.77 - 2.99. The averages were:

Core #	Void Ratio
782	2.56
785	2.27
786	2.43

F. Grain Size

The pipette analyses were run to determine the grain size distribution. The results are shown in Table 4. Since it is difficult to compare the individual grain size distribution, numerical means were applied in order to summarize the data. A convenient method to express grain size distribution is in terms of moment.

The first moment measured of the mean as

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{h} x_i - f_i$$

Where $\overline{X}$ denotes the mean, n denotes $\sum f_i$, x_i, the class mark for the ith

class interval, f_i, the observed absolute frequency, and h, the number of intervals.

The second moment: Standard deviation

$$S = \sqrt{\frac{1}{n} \sum_{i=1}^{h} (x_i - \bar{x})^2 f_i}$$

The third moment (a_3): Skewness

$$a_3 = \frac{\frac{1}{n} \sum_{i=1}^{h} (x_i - \bar{x})^3 f_i}{\left(\sqrt{\frac{1}{n} \sum_{i=1}^{h} (x_i - \bar{x})^2 f_i}\right)^3}$$

The fourth moment (a_4): Kurtosis

$$a_4 = \frac{\frac{1}{n} \sum_{i=1}^{h} (x_i - \bar{x})^4 f_i}{\left(\sqrt{\frac{1}{n} \sum_{i=1}^{h} (x_i - \bar{x})^2 f_i}\right)^4}$$

The grain size statistical parameters are listed in Table 5. They show rather uniform distribution.

6. SEDIMENT SOUND VELOCITY

Measurements of sound velocities were made at HIG under lab temperatures and atmospheric pressures. The velocimeter used was developed by the Ling Temco Vought Research Center/Hawaiian Division (Dahlke, 1968; Southworth, 1968; Dahlke and Southworth, in press). This instrument was developed as a portable unit and was successfully operated during the 1968 ONR/NSF Solomon Islands/Darwin Rise research cruise of the Hawaii Institute of Geophysics.

With the exception of an oscilloscope to measure time delays, all electronics are contained in the velocimeter frame itself. It can be moved along the core or clamped with the core moved (vertically or horizontally).

The cores were marked so as to make four velocity determinations at each measurement location (i.e. at 45° angles). Measurements were made starting at 5 cm (from the sediment surface), and thereafter at every 10 cm. Measurements of the outside diameter, D_s, and delay time, T_s, were made each time. Sediment temperature was measured with a thermometer to ±0.2°C. Calibration measurements were made on a distilled water standard cell enclosed in a piece of the same kind of liner. From the temperature of the water standard the velocity in water, V_r, was read from Wilson's Tables for sound velocity in water vs. temperature (Wilson, 1959). An average liner wall thickness, T_w = 0.108", was assumed in completing the simplified equation for sediment sound velocity, V_s, as follows:

$$V_s = \frac{(D_s - 2t_w)V_r}{(D_r - 2t_w) - V_r \Delta T}$$

T is a measure of the difference in delay time measurements in the sediment and the water standard. Calculation was done with an Olivetti Programma Computer. No corrections were made for <u>in situ</u> depth or pressure under the assumption that the inverse relations of the effects give values close to lab measurements at most oceanic depths. The velocity logs are given in Tables 6, 7, and 8.

Figure 12 is a compilation of velocity profiles for the three cores. Little variation appeared in the velocities of cores 782 and 785 (maximum variation of 0.3% each for all determinations in core). Core 786 showed

greater variation in determinations 55 cm and deeper (about 2.0% maximum variation). Average measureements in each core were as follows:

Core #	Sound Velocity
782	1492 m/sec
785	1484 m/sec
786	1503 m/sec

7. RESULTS ON SHEAR STRENGTH MEASUREMENTS

Measurements were made on the surface of the split core with a TORVANE (Soiltest, Inc.) using the sensitive vane (0-0.2 tons/square-foot range). Owing to the soft nature of the sediment and possible artificial surface disturbance, measurements were made starting at the 20 cm depth of each core and each subsequent 20 cm interval (Figure 13). All three showed shear strengths of 0.034 tons/sq. ft. at the 20 cm depth. This appears to be a fairly representative value, i.e. subsequent deeper measurements were greater (maximum 0.050 tons/sq. ft.) or less than (minimum 0.026 tons/sq. ft.) that figure.

8. SUMMARY

Although the sediments for each of the three cores studied are typical of pelagic oceanic deposits there are considerable variations in the certain physical properties (see Fig. 14) indicating that even in a restricted area it is difficult to obtain a representative sample because of a variable history of sediment deposition.

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Dahlke, H. E. (1968). A portable instrument for measuring compressional sound velocities on unopened marine sediment cores, Ling Temco Vought Research Center/ Hawaiian Division, Report No. 0-71300/8R-203, Feb. 1968, 24 pp.

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Rex, R. W. and E. D. Goldberg (1958). Quartz content of pelagic sediments of the Pacific Ocean. Tellus, vol. 10, pp. 153-159.

Southworth, J. H. (1968). Application of LTV portable core velocimeter on studies of marine sediments, liquids, and solids, Ling Temco Vought Research Center/Hawaiian Division, Report No. 0-71300/8R-211, Nov. 1968, 43 pp.

Sutton, G. H., H. Berckhemer and J. C. Nafe (1957). Physical properties of deep sea sediments, Geophysics, vol. 22, pp. 779-812.

Wilson, W. D. (1959). Speed of sound in distilled water as a function of temperature and pressure, Jour. Acoust. Soc. Am., vol. 31, pp. 1067-1072.

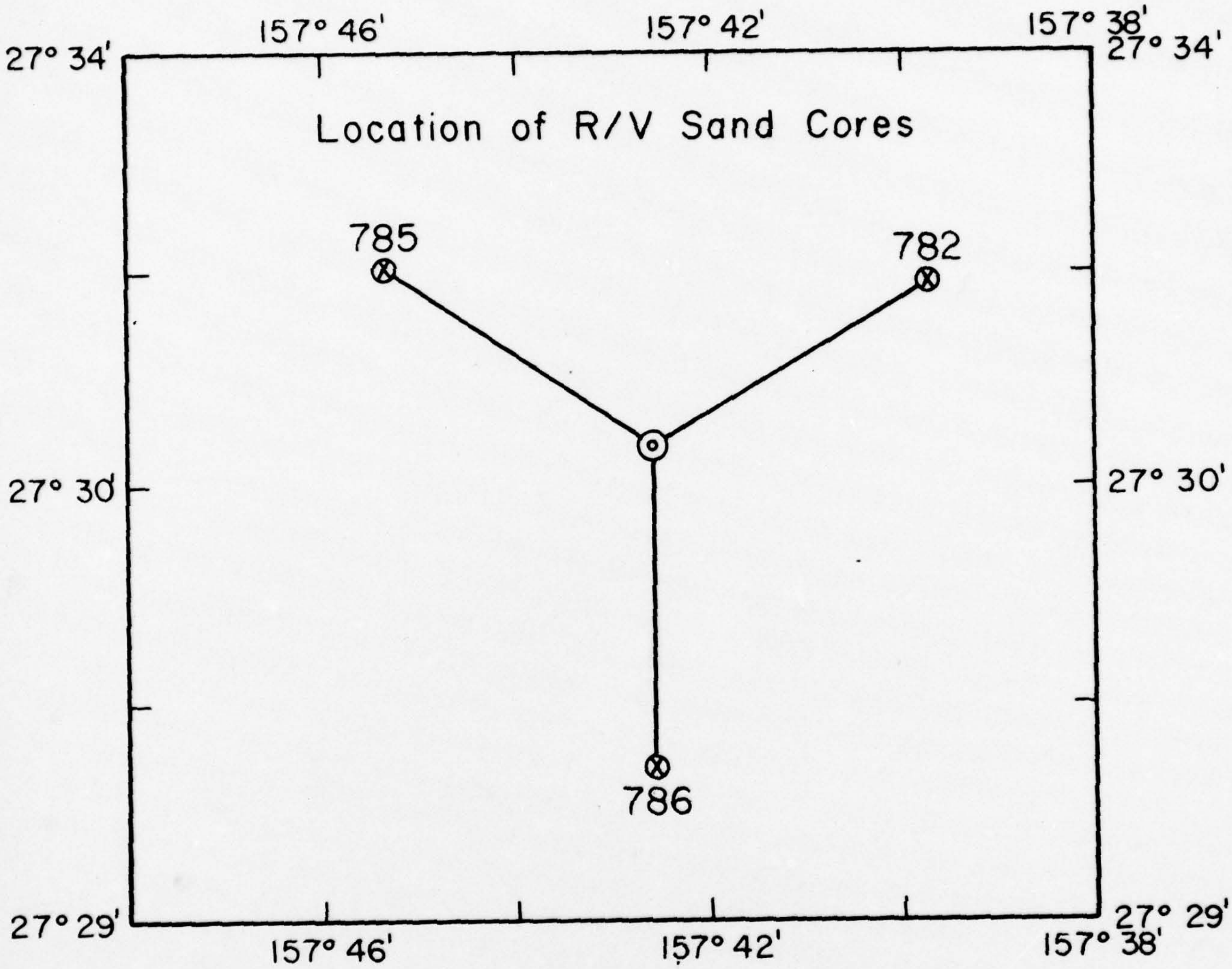
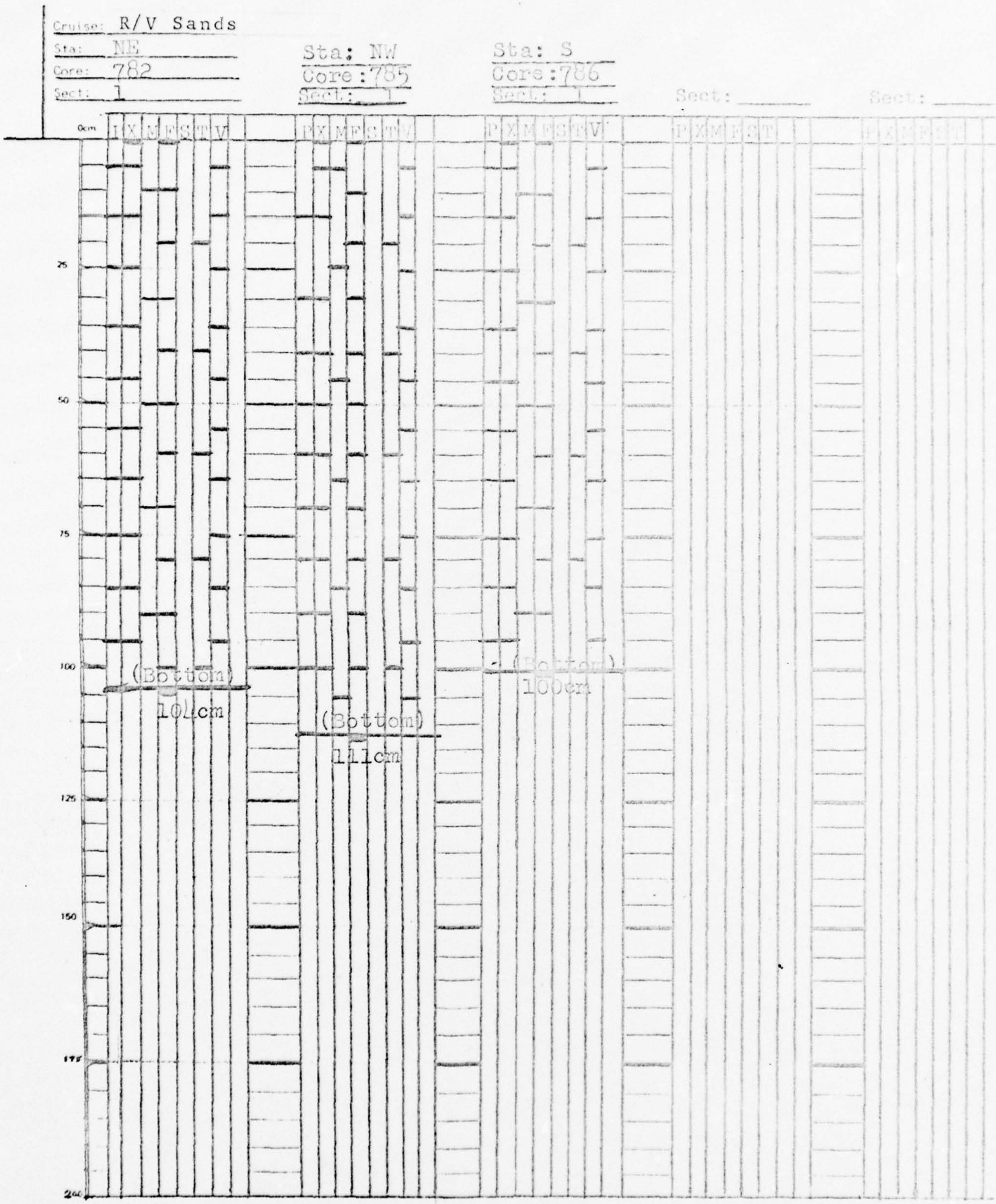

Location of R/V Sand Cores
157° 46'
157° 42'
157° 38'
27° 34'
27° 34'
27° 30'
27° 30'
27° 29'
27° 29'
157° 46'
157° 42'
157° 38'
785
782
786

Fig.1

CORE SAMPLING FORM

LOGGING PROGRAM SHEET

FIGURE 2



SAMPLING SITE CODE:

P: Porosity X: Xray M: Paleomagnetics F: Faunal S: Smear slide T: Shear strength

V: Sound Velocity Determination

8/69

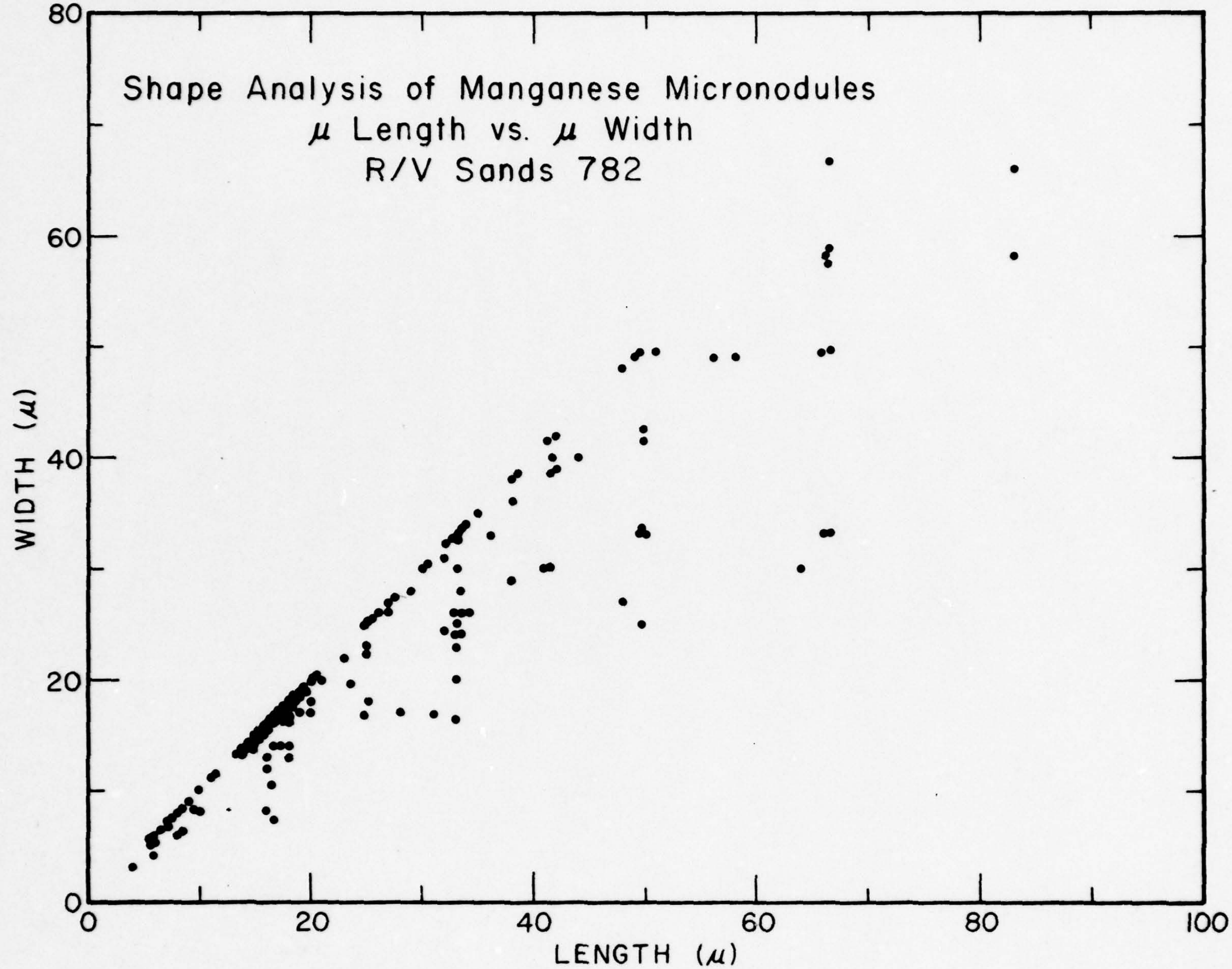

Shape Analysis of Manganese Micronodules
μ Length vs. μ Width
R/V Sands 782
WIDTH (μ)
LENGTH (μ)
0
20
40
60
80
100

Fig.3

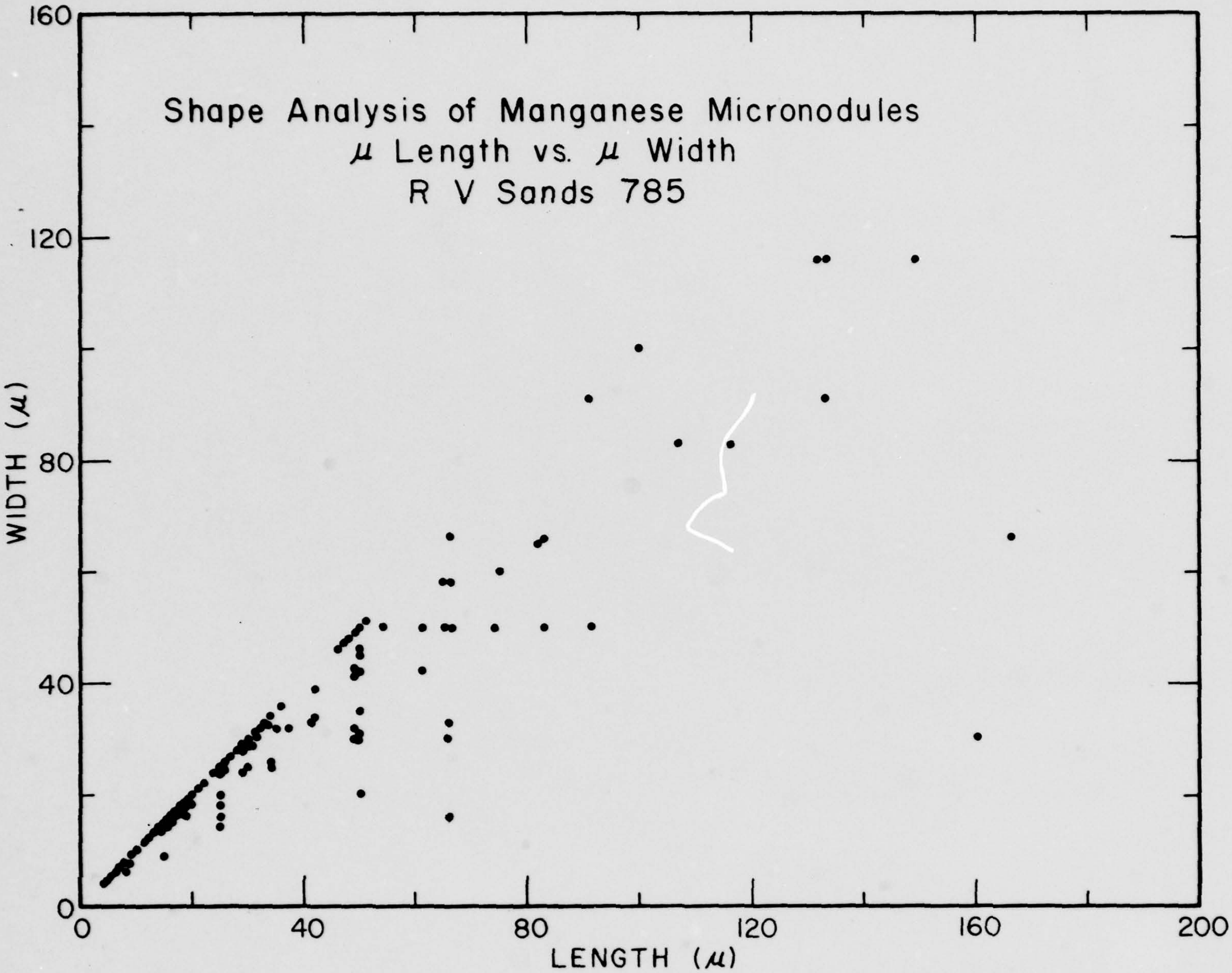

Shape Analysis of Manganese Micronodules
μ Length vs. μ Width
R V Sands 785
WIDTH (μ)
LENGTH (μ)
0
40
80
120
160
200

Fig. 4

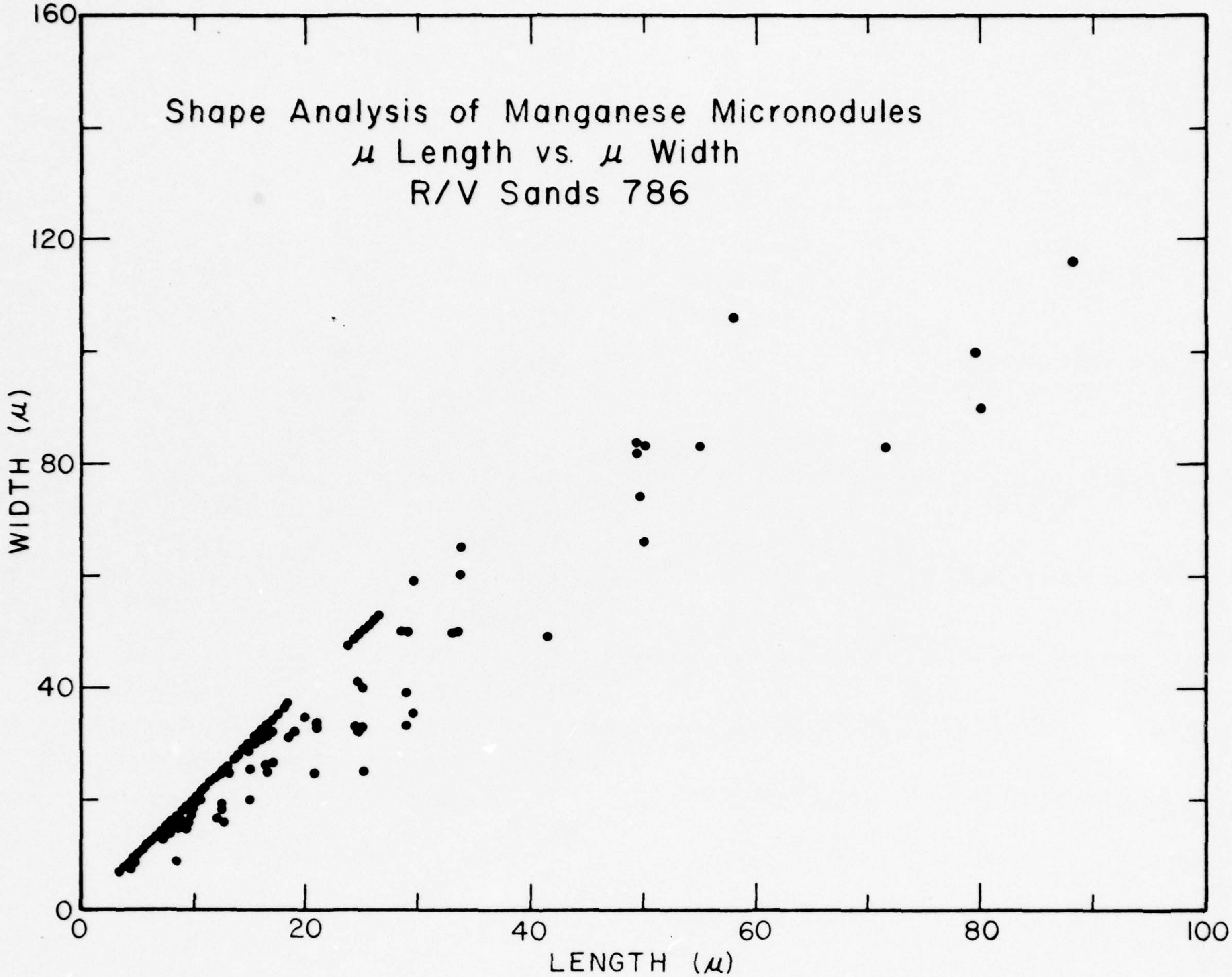

Shape Analysis of Manganese Micronodules
μ Length vs. μ Width
R/V Sands 786
160
120
80
40
0
WIDTH (μ)
0
20
40
60
80
100
LENGTH (μ)

Fig. 5

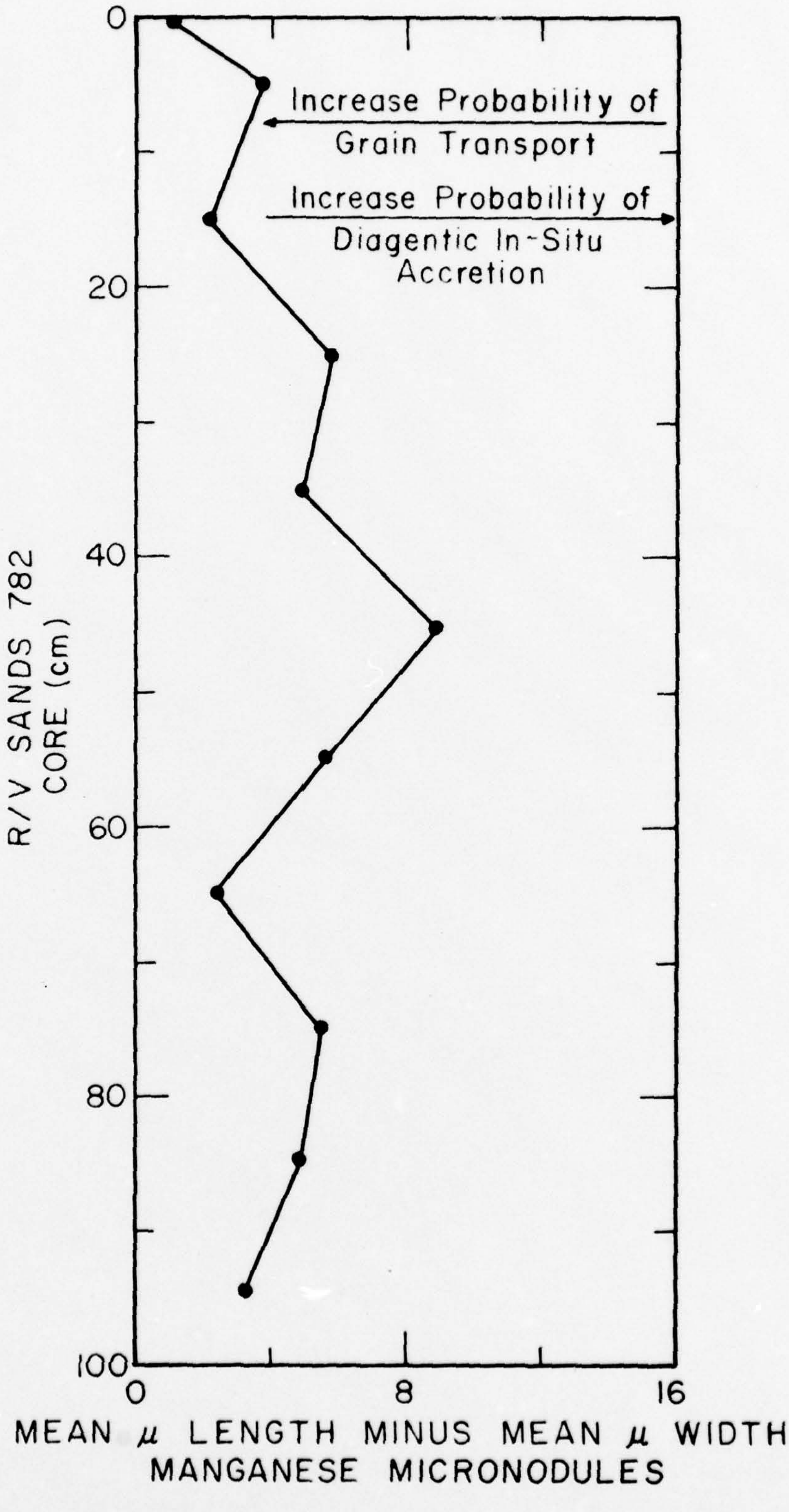

Increase Probability of
Grain Transport
Increase Probability of
Diagentic In-Situ
Accretion
0
20
40
60
80
100
R/V SANDS 782
CORE (cm)
0
8
16
MEAN μ LENGTH MINUS MEAN μ WIDTH
MANGANESE MICRONODULES

Fig.6

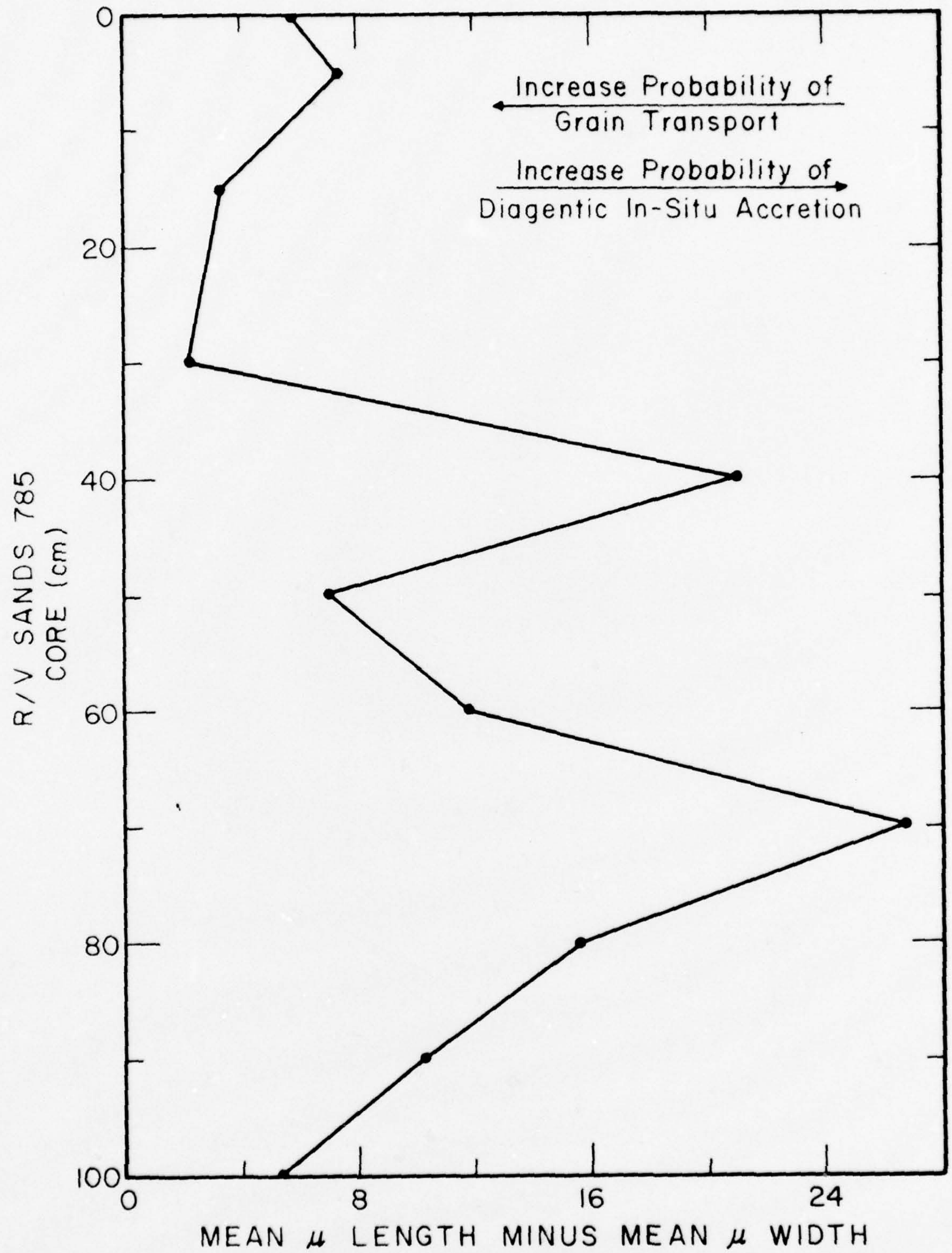
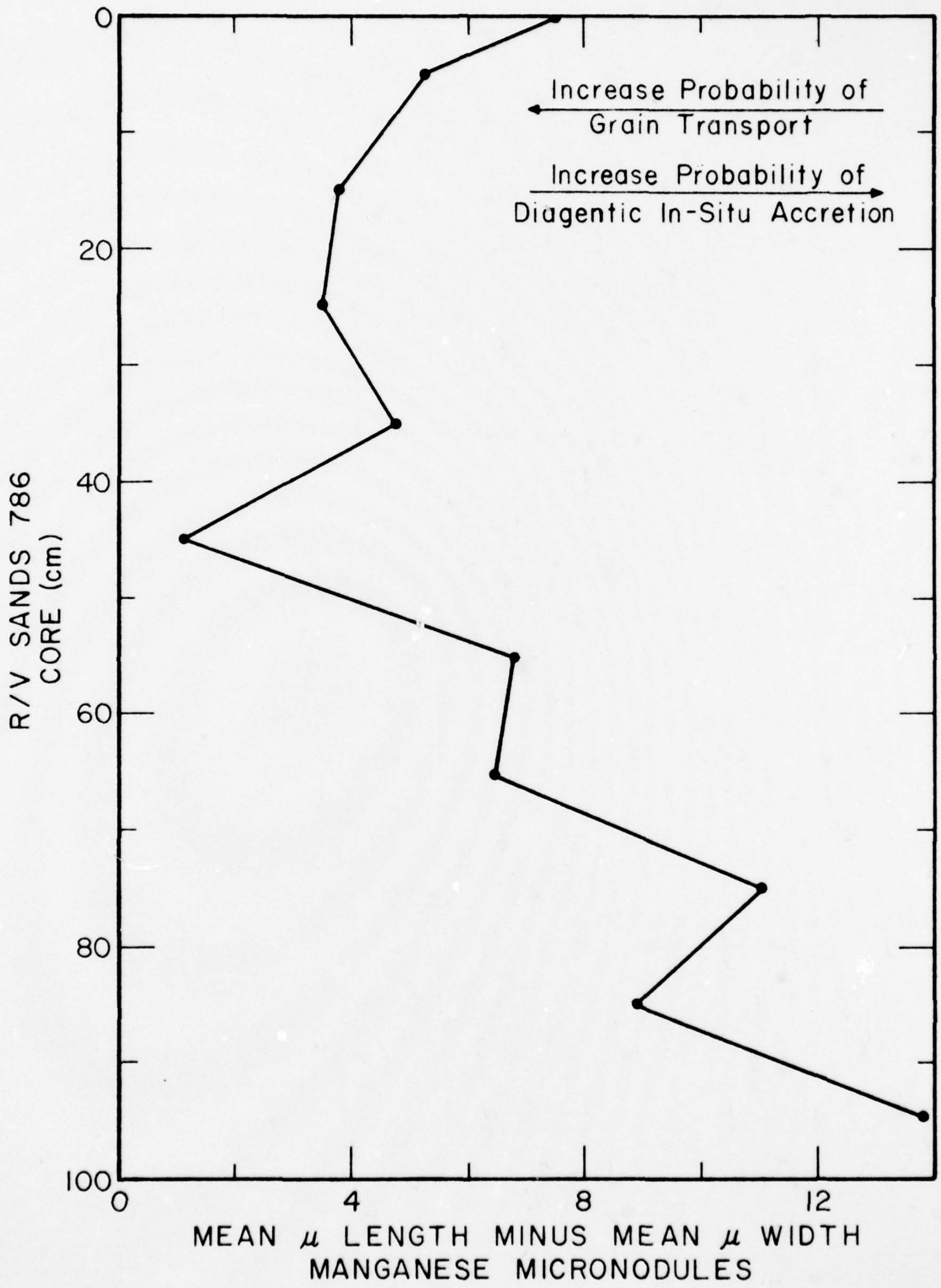

0
20
40
60
80
100
R/V SANDS 785
CORE (cm)
Increase Probability of
Grain Transport
Increase Probability of
Diagentic In-Situ Accretion
0
8
16
24
MEAN μ LENGTH MINUS MEAN μ WIDTH
MANGANESE MICRONODULES

Fig. 7



Increase Probability of
Grain Transport
Increase Probability of
Diagentic In-Situ Accretion
R/V SANDS 786
CORE (cm)
0
20
40
60
80
100
0
4
8
12
MEAN μ LENGTH MINUS MEAN μ WIDTH
MANGANESE MICRONODULES

Fig. 8

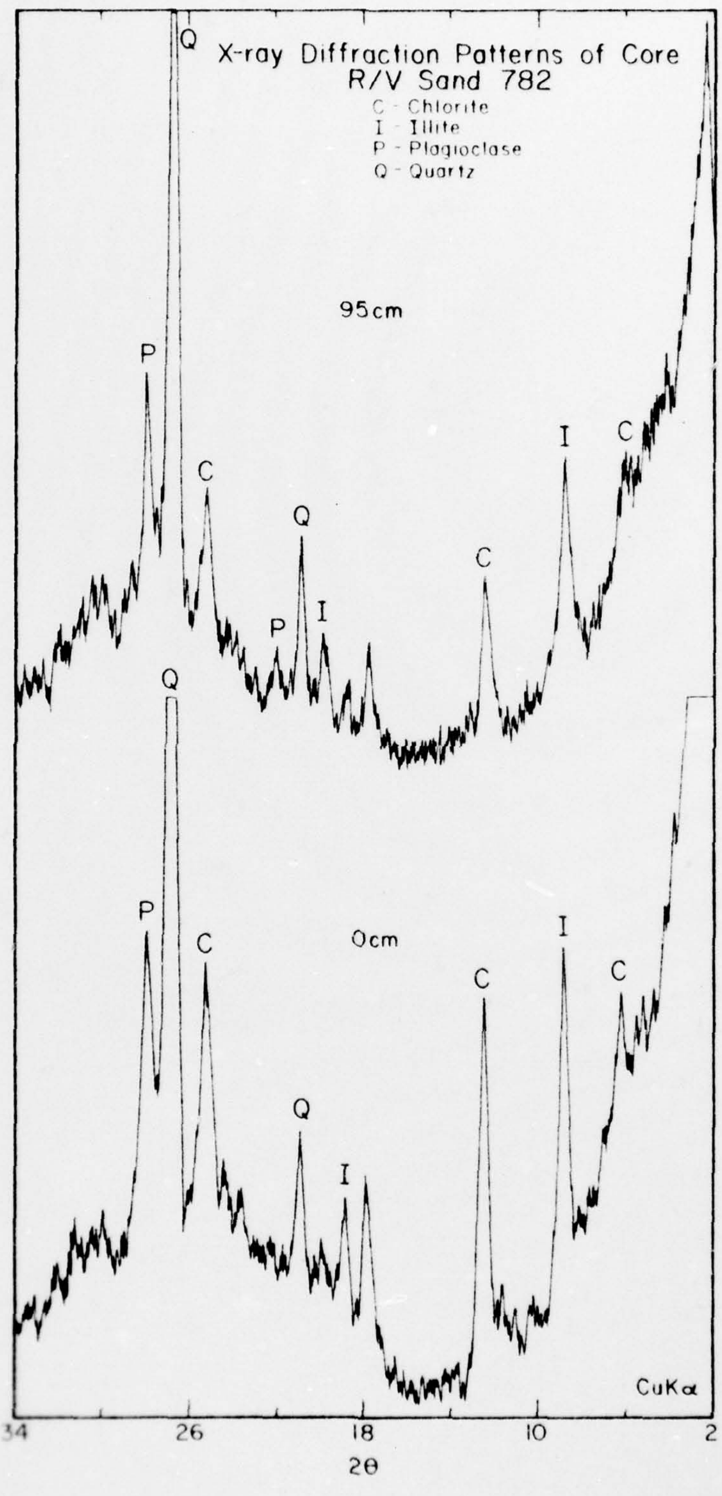

X-ray Diffraction Patterns of Core
R/V Sand 782
C - Chlorite
I - Illite
P - Plagioclase
Q - Quartz
95cm
0cm
P
Q
C
I
CuKα
34
26
18
10
2
2θ

Fig. 9

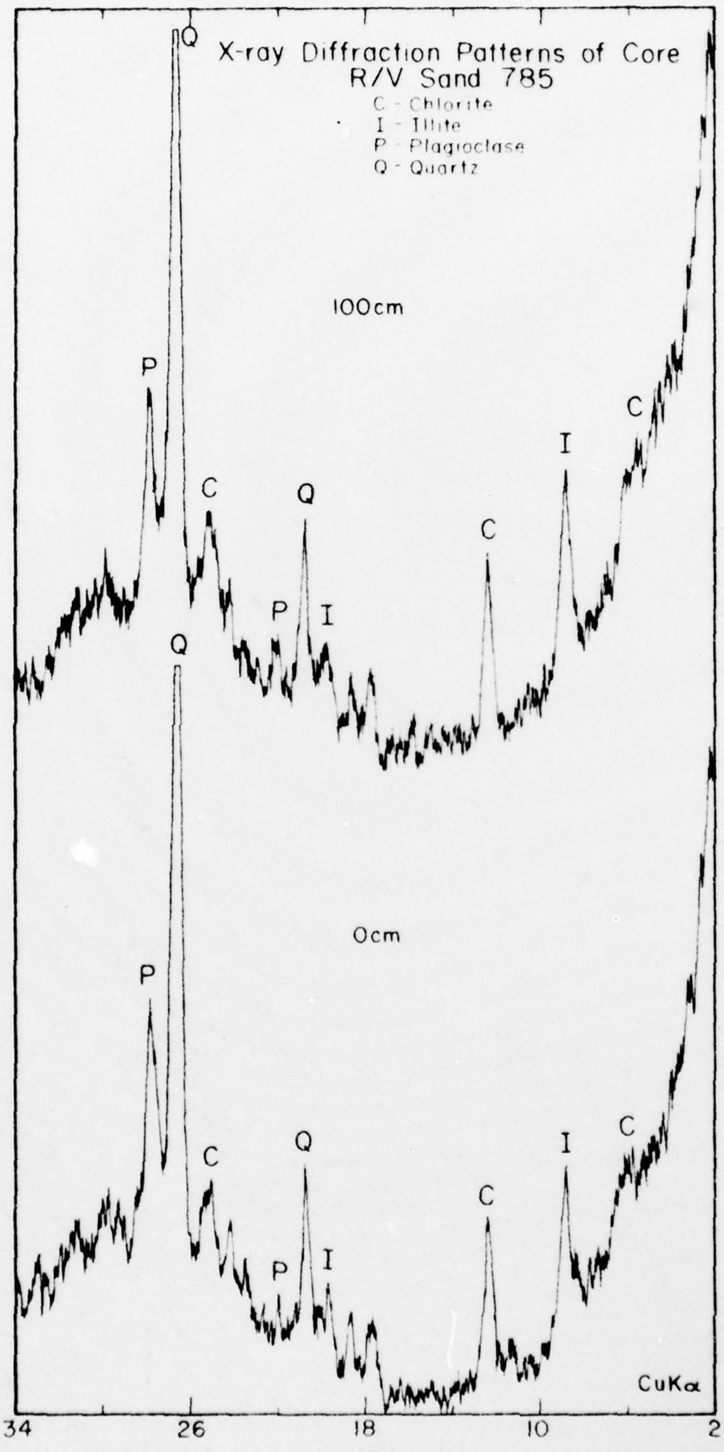

X-ray Diffraction Patterns of Core
R/V Sand 785
C - Chlorite
I - Illite
P - Plagioclase
Q - Quartz
100cm
0cm
P
Q
C
P
I
C
I
C
CuKα
34
26
18
10
2
2θ

Fig.10

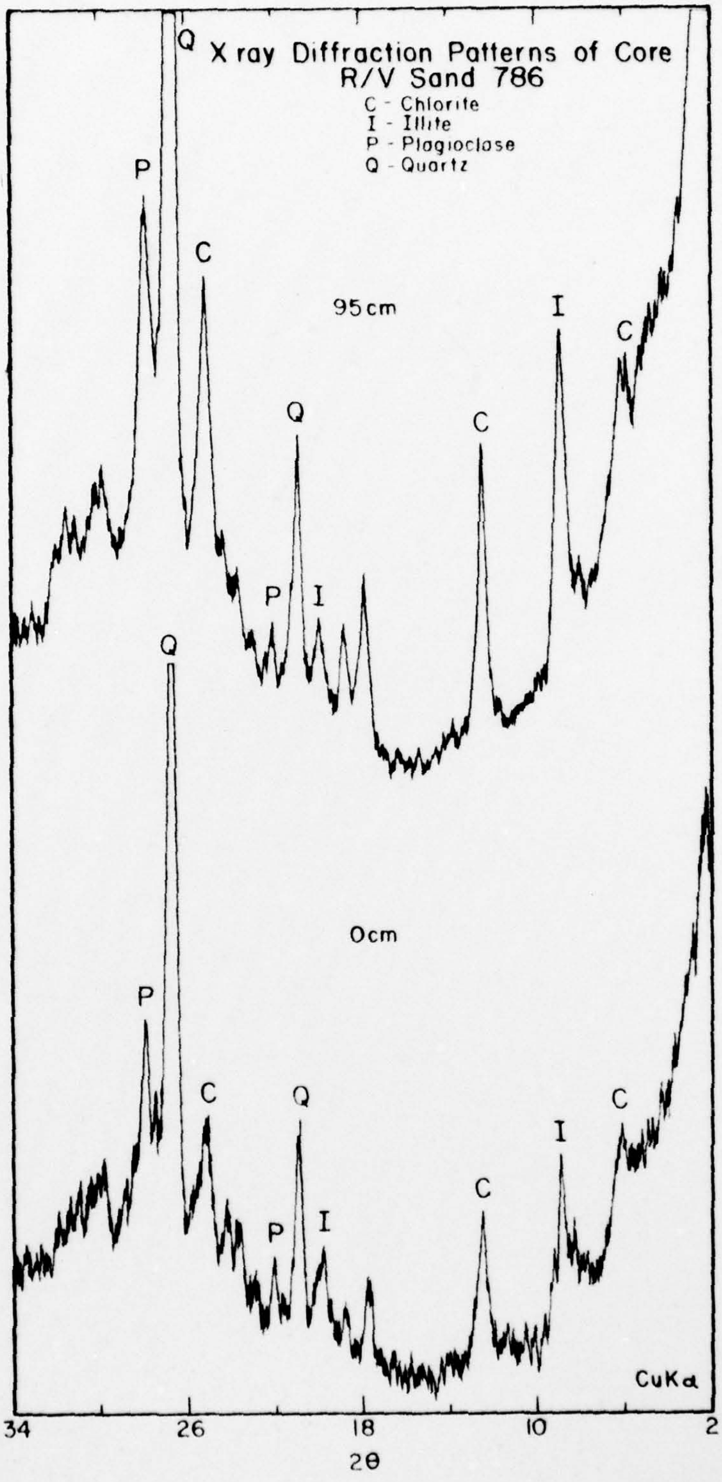

X ray Diffraction Patterns of Core
R/V Sand 786
C - Chlorite
I - Illite
P - Plagioclase
Q - Quartz
95cm
0cm
P
Q
C
I
CuKα
34
26
18
10
2
2θ

Fig.11

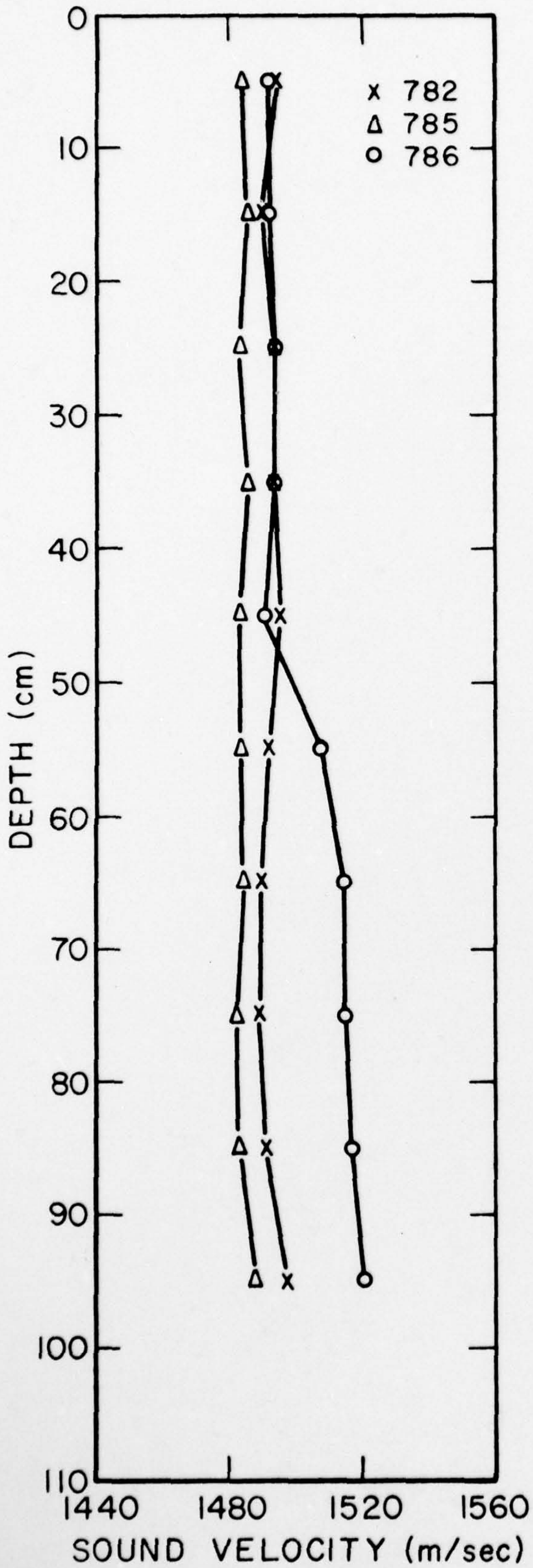

x 782
Δ 785
o 786
DEPTH (cm)
0
10
20
30
40
50
60
70
80
90
100
110
1440
1480
1520
1560
SOUND VELOCITY (m/sec)

Fig. 12

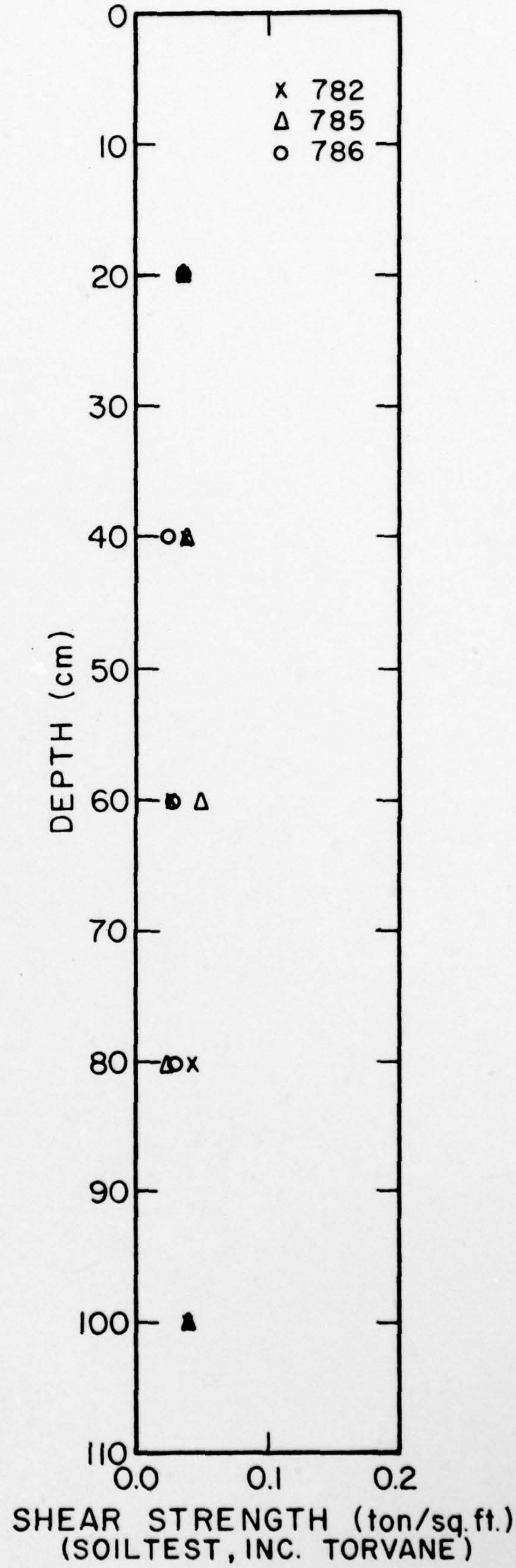

x 782
Δ 785
o 786
DEPTH (cm)
0
10
20
30
40
50
60
70
80
90
100
110
0.0
0.1
0.2
SHEAR STRENGTH (ton/sq. ft.)
(SOILTEST, INC. TORVANE)

Fig. 13

Physical Properties of Cores 782(★), 785(□) & 786(●)

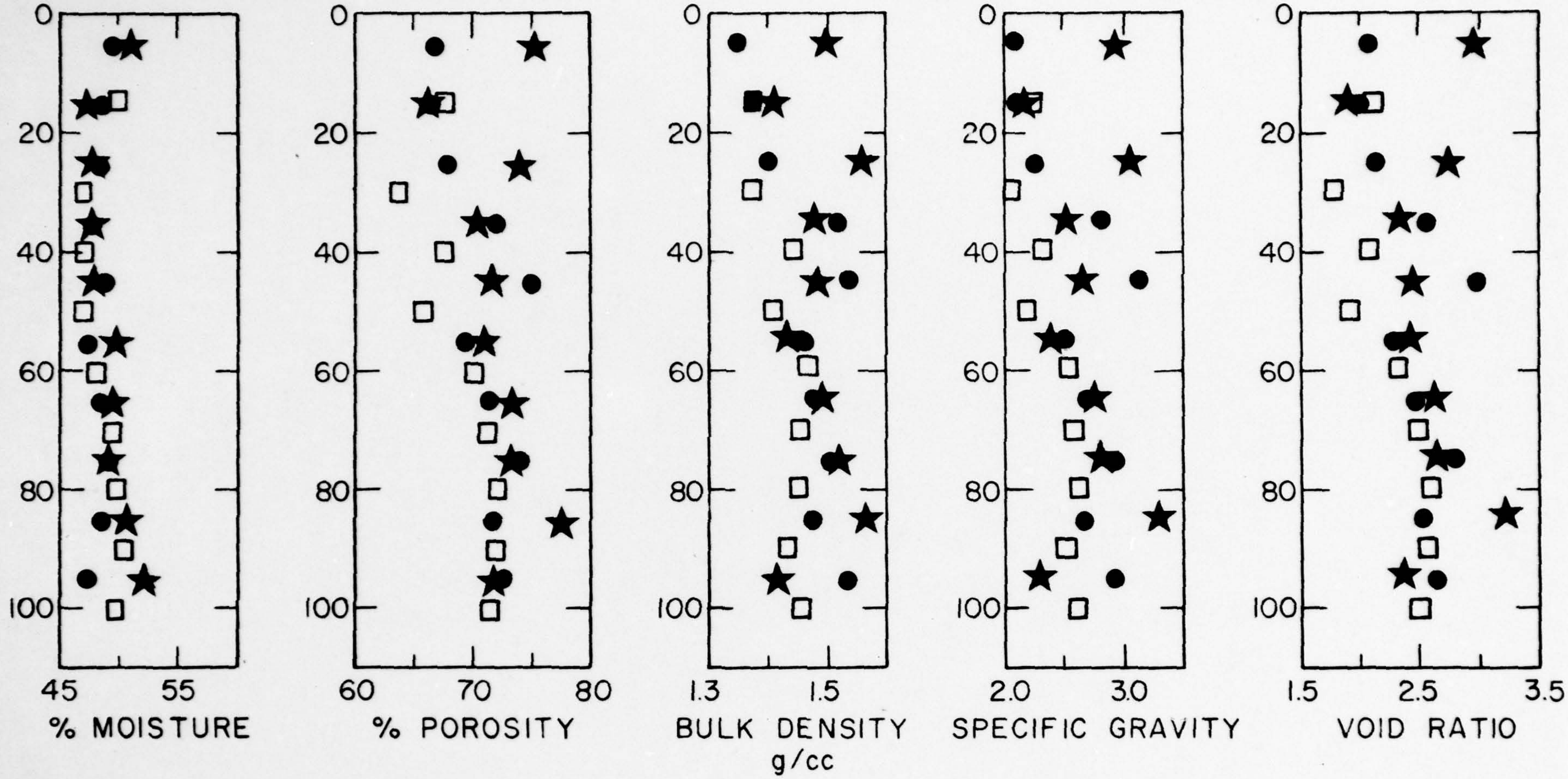


Fig. 14

PHYSICAL PROPERTIES DATA LOG FORM

DATE 15 Aug 69

CRUISE R/V Sands

CORE FFC 785-N.W.

SECTION 2

LENGTH RANGE 0-111

TOP 0.0

WATER HEAD No

SHRINKAGE --

SEDIMENT TEMPERATURE 20.2 °C

I. SHEAR STRENGTH

DEPTH, cm	READING	SHEAR STRENGTH, T.S.F.
20	1.7	0.034
40	1.9	0.038
60	2.5	0.050
80	1.3	0.026
100	1.8	0.036

II. POROSITY AND PHYSICAL PROPERTIES

OVEN IN: 18 Aug 69

OUT: 21 Aug 69

A: BULK DENSITY
B: % WATER (WET)
C: POROSITY
D: SPEC. GR.
E: VOID RATIO

DEPTH cm	VIAL NO.	WET WT.	DRY WT.	VIAL WT.	SAMPLE SIZE	A	B %	C %	D	E
5					No Sample					
15	83	26.47	19.76	12.71	0.8 air	1.37	48.8	67.6	2.20	2.09
30	84	31.39	22.67	12.71	1.1 air	1.37	46.7	63.9	2.02	1.77
40	85	30.54	22.15	12.70	1.0 air	1.44	47.0	67.7	2.36	2.09
50	86	26.63	20.09	12.66	0.8 air	1.41	46.8	65.9	2.20	1.93
60	87	34.42	23.99	12.68	1.2 air	1.46	48.0	70.1	2.54	2.34
70	88	34.30	23.68	12.70	1.2 ok	1.45	49.2	71.4	2.58	2.49
80	89	34.33	23.58	12.68	1.2 air	1.45	49.7	72.2	2.64	2.60
90	90	35.70	24.19	12.40	1.3 ok	1.43	50.2	71.9	2.54	2.56
100	91	36.24	24.69	12.70	1.3 ok	1.46	49.1	71.6	2.62	2.53

PHYSICAL PROPERTIES DATA LOG FORM

DATE 15 Aug 69

CRUISE R/V Sands

CORE FFC 786-South

SECTION 1

LENGTH RANGE 0-100 cm

TOP 0.0

WATER HEAD Yes

SHRINKAGE --

SEDIMENT TEMPERATURE 20.0 °C

I. SHEAR STRENGTH

DEPTH, cm	READING	SHEAR STRENGTH, T.S.F.
20	1.7	0.034
40	1.4	0.028
60	1.5	0.030
80	1.6	0.032

II. POROSITY AND PHYSICAL PROPERTIES

OVEN IN: 18 Aug 69

OUT: 21 Aug 69

A: BULK DENSITY
B: % WATER (WET)
C: POROSITY
D: SPEC. GR.
E: VOID RATIO

DEPTH cm	VIAL NO.	WET WT.	DRY WT.	VIAL WT.	SAMPLE SIZE	A	B	C	D	E
5	73	25.20	18.95	12.68	0.75Air	1.35	49.9	67.2	2.06	2.05
15	74	32.99	23.16	12.67	1.2 Air	1.37	48.4	66.1	2.08	1.95
25	75	25.44	19.43	12.71	0.75 Air	1.40	48.4	67.8	2.25	2.11
35	76	35.10	24.42	12.66	1.2 Air	1.51	47.6	71.8	2.80	2.54
45	77	35.61	24.46	12.69	1.2 Air	1.54	48.6	74.9	3.15	2.99
55	78	32.60	23.14	12.67	1.1 Air	1.46	47.5	69.3	2.50	2.26
65	79	38.30	25.95	12.67	1.4 Air	1.48	48.2	71.1	2.65	2.46
75	80	34.96	23.98	12.66	1.2 ok	1.50	49.2	73.8	2.90	2.81
85	81	27.33	20.21	12.72	0.8 Air	1.47	48.7	71.8	2.67	2.54
95	82	37.33	25.60	12.70	1.3 ok	1.53	47.3	72.4	2.91	2.62

TABLE 3

PHYSICAL PROPERTIES DATA LOG FORM

DATE 15 Aug 69

CRUISE R/V Sands

CORE FFC 782-NE

SECTION 1

LENGTH RANGE 0-104 cm

TOP 00

WATER HEAD Yes

SHRINKAGE --

SEDIMENT TEMPERATURE 24.5 °C

I. SHEAR STRENGTH

DEPTH, cm	READING	SHEAR STRENGTH, T.S.F.
20	1.7	0.034
40	1.9	0.038
60	1.5	0.030
80	2.2	0.044
100	2.1	0.042

II. POROSITY AND PHYSICAL PROPERTIES

OVEN IN: 18 Aug 69

OUT: 21 Aug 69

A: BULK DENSITY
B: % WATER (WET)
C: POROSITY
D: SPEC. GR.
E: VOID RATIO

DEPTH cm	VIAL NO.	WET WT.	DRY WT.	VIAL WT.	SAMPLE SIZE	A	B	C	D	E
5	92	31.09	21.83	12.70	1.0Air	1.48	50.4	74.7	2.91	2.95
15	93	28.26	20.97	12.68	0.9 ok	1.40	46.8	65.3	2.14	1.88
25	94	35.59	24.68	12.67	1.2OK	1.54	47.6	73.3	3.02	2.75
35	95	32.69	23.17	12.70	1.1 Air	1.47	47.6	69.8	2.54	2.31
45	96	36.48	25.07	12.72	1.3 ok	1.47	48.0	70.8	2.62	2.42
55	97	30.25	21.53	12.71	1.0 Air	1.41	49.7	70.3	2.40	2.37
65	98	32.66	22.76	12.66	1.1 Air	1.47	49.5	72.6	2.70	2.65
75	99	29.46	21.36	12.69	0.9 Air	1.50	48.3	72.6	2.83	2.65
85	100	33.73	23.32	12.68	1.1 ok	1.54	49.5	76.3	3.29	3.22
95	101	31.52	21.94	12.68	1.1 ok	1.38	50.8	70.2	2.28	2.36

TABLE 4

Grain Size Distribution

Samples (% Weight)

ϕ	μ	782 5 cm	782 55 cm	782 95 cm	785 5 cm	785 50 cm	785 95 cm	786 5 cm	786 55 cm	786 95 cm
4-4.5	63-44	0.09	0.79	1.60	2.81	0.95	0.97	0.25	1.20	0.99
4.5-5	44-31	0.09	0.41	0.90	2.97	0.95	1.01	0.06	1.20	1.30
5-5.5	31-22	0.09	1.99	0.60	8.46	0.29	1.24	0.96	1.20	1.30
5.5-6	22-16	0.70	1.53	0.19	0.69	0.62	2.49	0.67	1.70	1.70
6-7	16-7.8	8.30	9.23	4.50	3.47	4.29	3.04	2.18	7.00	8.00
7-8	7.8-3.9	6.00	5.23	10.20	11.40	11.46	10.72	9.76	1.10	4.40
8-9	3.9-2	19.20	16.67	23.10	14.04	22.63	14.07	20.24	23.20	20.90
9-10	2-1	22.70	20.50	20.80	19.60	20.64	18.13	20.74	18.70	20.00
10-11	1-0.5	15.10	14.65	14.30	12.56	10.98	17.86	14.11	15.10	14.80
>11	<0.5	27.50	29.77	23.60	23.96	27.14	30.49	30.98	29.60	26.60

TABLE 5

Computation of Grain Size Statistical Parameters

Sample	Mean	Standard Deviation	Skewness	Kurtois
782- 5 cm	9.58	1.61	-0.44	2.36
782- 55 cm	9.56	1.85	-0.81	2.73
782- 95 cm	9.37	1.70	-0.59	3.17
785- 5 cm	8.97	2.19	-0.61	2.30
785- 50 cm	9.43	1.70	-0.49	2.84
785- 95 cm	9.60	1.82	-0.82	2.99
786- 5 cm	9.71	1.57	-0.53	2.67
786- 55 cm	9.56	1.81	-0.85	3.23
786- 95 cm	9.41	1.83	-0.69	2.84

TABLE 6

SEDIMENT VELOCIMETER LOG

1. Calibration of dial gage: 2702 " ≡ 0212 dial reading
2. Standard Measurements

2tw = 0.216"
D_r = 2.820"
V_r = 0.05903 " sec^{-6}
T_r = 46.4 sec^{-6}
Standard Temperature 26.0 °C

Core Number: N.W. FFC-785(1)
Date/Cruise: Aug '69 / R/V Sands
Position: 157 ° 46'W 'Long 27°33'N 'Lat.
Water Depth ~3800m
Sediment Temperature 25.8 °C

3. Sediment Sound Velocity Measurements

DEPTH (cm) from top of sediment	DIAMETER D_s" (gage)	D_s Corrected	TIME T_s (sec^{-6})	VELOCITY V_s (m/sec)	Average VELOCITY $\overline{V}_s$	REMARKS
95	2.834		46.94			
	2.824	2.831/	46.83			
	2.828	/46.93	46.85	1488		
	2.838		47.09			
85	2.839		47.18			
	2.827	2.831/	47.02			
	2.824	/47.09	47.02	1483		
	2.834		47.08			
75	2.835		47.20			
	2.830		47.07			
	2.834	2.834/	47.08			
	2.836	/47.14	47.19	1483		
65	2.835		47.17			Power failure 1155 charged wall outlet
	2.828		46.97			
	2.824	2.829/	46.87			
	2.829	/47.01	47.02	1484		
55	2.830		47.05			
	2.824	2.829/	46.90			
	2.827	/47.00	46.96	1484		
	2.835		47.08			
45	2.832		47.09			
	2.825	2.826/	46.95			
	2.821	/47.01	46.96	1483		
	2.828		47.04			
35	2.828		46.95			
	2.827		46.88			
	2.827	2830/	47.00			
	2.837	/46.99	47.11	1485		
25	2.832		47.10			
	2.826	2.826/	46.97			
	2.820	/47.00	46.92	1483		
	2.827		47.00			
15	2.823		46.97			
	2.825	2.828/	46.88			
	2.829	/46.96	46.95	1485		
	2.834		47.06			
5	2.830		47.18			
	2.830	2.832/	47.08			
	2.833	/47.18	47.02	1483		
	2.833		47.02			

Average $\overline{V}_s$ = 1484 m/sec

SEDIMENT VELOCIMETER LOG

1. Calibration of dial gage: 2.702 " ≡ .212 dial reading
2. Standard Measurements

$2t_w$ = 0.216"
D_r = 2.789"
V_r = 0.05906" sec^{-6}
T_r = 47.8 sec^{-6}
Standard Temperature 26.3 °C

Core Number: SFFC-786(1)
Date/Cruise: Aug '69 / R/V Sands
Position: 157° 44'W 'Long. 27°29'N 'Lat.
Water Depth ~ 3800m
Sediment Temperature 26.2 °C

3. Sediment Sound Velocity Measurements

DEPTH (cm) from top of sediment	DIAMETER D_s" (gage)	D_s Corrected	TIME T_s (sec^{-6})	VELOCITY V_s (m/sec)	Average VELOCITY $\overline{V}_s$	REMARKS
95	2.817		47.6			
	2.814	2.818/	47.6			
	2.817	/47.68	47.7	1521		
	2.823		47.8			
85	2.781		47.1			
	2.775	2.776/	47.1			
	2.774	/47.15	47.1	1517		
	2.772		47.1			
75	2.773		47.1			
	2.773	2.772/	47.1			
	2.772	/47.10	47.1	1515		
	2.772		47.1			
65	2.774		47.0			
	2.766	2.773/	47.0			
	2.773	/47.10	47.1	1515		
	2.780		47.3			
55	2.783		48.1			
	2.779	2.781/	47.3			
	2.780	/47.48	47.3	1507		
	2.783		47.2			
45	2.785		48.0			
	2.782	2.782/	47.9			
	2.779	/47.92	47.9	1491		
	2.780		47.9			
35	2.782		47.9			
	2.790	2.786/	48.0			
	2.789	/47.95	48.0	1494		
	2.785		47.9			
25	2.781		47.8			
	2.781	2.784/	47.8			
	2.787	/47.90	48.0	1494		
	2.788		48.0			
15	2.788		48.1			
	2.784	2.783/	47.9			
	2.781	/47.92	47.9	1492		
	2.779		47.8			
5	2.780		47.9			
	2.784	2.782/	48.0			
	2.784	/47.93	48.0	1492		
	2.779		47.8			

Average $\overline{V}_s$ = 1503 m/sec

SEDIMENT VELOCIMETER LOG

1. Calibration of dial gage: 2.702 " ≡ .212 dial reading
2. Standard Measurements

$2t_w$ = 0.216"
D_r = 2.801"
V_r = 0.0917 " sec^{-6}
T_r = 46.62 sec^{-6}

Standard Temperature 27.4 °C

Core Number: N.E. FFC-782(1)
Date/Cruise: Aug '69 / R/V Sands
Position: 157° 42'W 'Long. 27°33'N 'Lat.
Water Depth ~ 3800m
Sediment Temperature 27.3 °C

3. Sediment Sound Velocity Measurements

DEPTH (cm) from top of sediment	DIAMETER D_s" (gage)	D_s Corrected	TIME T_s (sec^{-6})	VELOCITY V_s (m/sec)	Average VELOCITY $\overline{V}_s$	REMARKS
95	2.788		46.67			
	2.785	2.784/	46.57			
	2.778	/46.50	46.32	1497		
	2.783		46.45			
85	2.780		46.63			Increased amplitude
	2.781	2.785/	46.60			
	2.789	/46.68	46.73	1491		
	2.789		46.77			
75	2.790		46.83			
	2.791	2.788/	46.87			
	2.788	/46.79	46.74	1490		
	2.784		46.71			
65	2.777		46.60			
	2.781	2.784/	46.60			
	2.790	/46.71	46.80	1490		
	2.788		46.83			
55	2.792		46.80			
	2.795	2.791/	46.85			
	2.790	/46.76	46.72	1492		
	2.787		46.68			
45	2.796		46.82			
	2.797		46.72			
	2.790	2.792/	46.64			
	2.787	/46.69	46.59	1495		
35	2.785		46.59			
	2.790	2.790/	46.65			
	2.793	/46.73	46.83	1493		
	2.793		46.86			
25	2.792		46.74			
	2.795	2.791/	46.75			
	2.791	/46.70	46.68	1494		
	2.787		46.64			
15	2.777		46.60			
	2.783	2.784/	46.62			
	2.790	/46.71	46.84	1490		
	2.788		46.78			
5	2.785		46.71			
	2.793	2.786/	46.79			
	2.785	/46.64	46.58	1493		
	2.781		46.50			

Average $\overline{V}_s$ = 1492 m/sec

APPENDIX H

UNIVERSITY OF HAWAII
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, Hawaii 96822

10 November, 1969

MEMO TO: Dr. G. P. Woollard

FROM: Antares Parvulescu

SUBJECT: Cruise Report, F.W.S. TOWNSEND CROMWELL, September 15 to 26, 1969

Objectives:

1. Installation and recovery of a vertical assembly of four current meters in the vicinity of PACIFIC SEA SPIDER implantment location.

2. Observation of the components of the above assembly, in order to determine the feasibility of inspection, by way of the CROMWELL sonar, of similar underwater assemblies, especially these assemblies to be later installed on the Sea Spider legs.

3. Evaluation of the same sonar system, for possible use as a motion sensing device to identify vibrations of taut buoy assemblies.

4. Observation of fish that may be attracted by such buoy assemblies.

5. Recordings of the sonar information for possible subsequent analysis.

6. Search for, and eventual recovery, of the current-measuring assembly lost on a previous cruise of Dr. Wyrtki's, at a location roughly enroute to the principal operating area of Sea Spider.

Operations:

Departed Kewalo Basin September 15 for location of lost Wyrtki buoy, approximately 23°18.5'N, 158°26.5'W. Approximately 10 hours were spent in

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REPORT OF WORK ACCOMPLISHED IN SUPPORT OF PARKA II OPERATIONS.(U)

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bathymetric identification of the location of the missing current meter string and in a sonar search for the missing buoy, reported by Dr. Wyrtki to be at 70 meter depth below mean sea level. Negative results; the buoy was not found.

Proceeded then to Sea Spider location where USNS SANDS and a large marker buoy were on station. Installation of current measuring assembly proceeded without hitch. The 2-ton concrete anchor was dropped under parachute control. The surface float indicated drift for nearly 24 hours before reaching a stabilized position, as estimated with reference to the marker buoy of Sea Spider and PARKA II experiments.

The current-measuring assembly was then used for the next six days as a sonar target for the CROMWELL's fish-research sonar. Two additional, surface-suspended vertical buoy assemblies were deployed, including several masses of iron (about 100 lbs. each) and elastic (shock-cord) links between these masses to provide a significant vertical oscillation within the vertical assembly. These assemblies were then used as additional targets in furtherance of objective #3; attempted measurement of motions of underwater components.

A current drogue was also rigged to determine near-surface current.

Constant radar plots were kept of the relative motions of CROMWELL, current-measuring buoy, marker buoy, current drogue and surface-suspended buoys. From these data an estimate of relative scope of the two moored buoys was obtained, indicating also the nature of the slow oscillations undergone by the marker buoy.

At the end of operations in this location, the current-measuring buoy was retrieved, all four sensors being safely recovered. The polypropylene mooring line, attached below the current instruments, was lost when the chain became jammed in the A-frame while under winch tension.

On the return trip an additional 12-hour search was carried out at the location of the lost Wyrtki buoy, including a very detailed bathymetric survey of the seamount top. The search was again unsuccessful.

Principal Results for Planned Objectives:

1. The current meters that were implanted were recovered in good condition. The data were analyzed by Geodyne, and are reported in Appendix F by Dr. Wyrtki. The recovery of the buoy assembly was only partly successful, in that there was a loss of about 12,000 ft. of polypropylene rope. The prolem was in part related to the ship's equipment, as the ship was not equipped with a winch suitable to bring in this line, and the improvised arrangement which had to be made while at sea did not prove adequate.

2. The current-measuring instruments (some 5 ft. long and 8 inches in diameter) were clearly seen on the CROMWELL fish-research sonar at ranges of 500 and 600 meters. The sonar operates a continuous-tone, frequency modulated narrow-beam, scanned either in azimuth or in elevation over several selectable sectors; operating frequency is swept from 32 to 48 khz and the sonar equation does predict detection at such ranges.

3. The CROMWELL's sonar also detected the smaller, cast-iron targets of our expendable "oscillating buoys" at ranges up to 400 and 500 meters, also within the sonar equation predictions.

The sonar's own signal processing does not have sufficient resolution to identify relative motion of individual targets even when the relative displacements were by design expected to be of the order of plus or minus 5 meters. The resolution also was too coarse to separate motion of the targets themselves, from the ship's motion.

Improvised signal processing could not enhance this resolution, although tape recordings brought to the laboratory might allow off-line enhancement of the resolution. This study has not yet been completed, due to lack of time for equipment development and data processing.

4. Observation of fish populations possibly attracted by the moored buoys was not a suitable objective. The presence in the buoy area of CROMWELL, SANDS, CONRAD (occasionally) and various Japanese fishing vessels complicated the experiment. The sonar did not detect any especially significant concentration of fish around the buoy.

5. Tape recordings were obtained for possible analysis off-line.

6. A detailed bathymetric survey of the sea-mount top where Dr. Wyrtki's lost buoy should be preceeded the sonar search for the buoy. The buoy could not be found on either of the two passes made. The second search was terminated when the sea state increased to the point of excessive noise both in the CROMWELL's high-resolution fish-research sonar, and in the 12-khz bathymetric sonar. The two other bathymetric sonars of the CROMWELL, operating at much higher frequencies, were also used but could not be expected to detect the missing buoy except if directly below the hull.

Additional, Unplanned Results and Findings:

7. The density of Japanese long-line tuna fishermen was reported to the Sea Spider implantment personnel, as it could present a serious problem of interference with the implantment operations. Current long-line tuna fishing was described by the B.C.F. personnel aboard the CROMWELL as using lines of 50 to 60 mile length, which are floated just below the sea surface and trailed there for nearly 24 hours per launch. This means that a rough rectangle of dimensions some 50 miles by 10 miles is swept by the fishing line every day, the latter dimension being the estimated drift of the fishing vessel and line during the 24-hour interval. It can be recalled that during the implantment operations in October, one ship alone (USS MARYSVILLE) serving as a radar picket, had to divert 13 separate fishing vessels from the vicinity of Sea Spider operations.

8. The radar tracking of the marker buoy, current buoy, and current drogue led to an estimate of motions of the two moored buoys. It is estimated that the marker buoy underwent a major circular oscillation, of diameter nearly 1 mile, with a period of about 14 hours. The marker buoy was reportedly installed with a 7,000 ft. excess of line length over water depth. The current-measuring moor on the other hand was nearly taut, using elastic polypropylene

line, and was probably close to stationary.

9. Assuming a constant current near the surface, the drogue led to an estimate of 0.24 knots bearing 315°True for the near-surface current on Sept. 22, 1969.

10. Despite the two-ton concrete anchor on the current-measuring buoy, the buoy took nearly a day to reach stability. This can not be explained merely by assuming that the parachute slowed its sinking rate. No other explanation is readily available. The drift was in excess of two miles, referenced to the marker buoy. As stated under (8), above, the marker buoy did oscillate about the mooring but not enough to account for this drift.

Equipment:

Failure of the upper clamp on one of the four current sensors caused it to turn upside down after three days and cease to record; the other sensors operated continuously without trouble.

The H.I.G. electronics personnel on the cruise were able to locate and repair a long-standing intermittent fault of the CROMWELL's sonar, bringing its operation up to manufacturers specifications.

Breakdown in the gearbox driving the chart recorder of the 12-khz EDO fathometer, forced us to improvise an A-scope display system which was used successfully during the second bathymetric survey at the missing buoy location. The manually-triggered system proved in fact to be superior to what a chart display might have achieved, since it allowed us to operate the sonar under very difficult noise conditions which would have wiped out a chart display.

Winch failures accompanied both attempted launches of the Bissett-Berman STD system; records were obtained but do not represent significant information about the acoustic environment during this period.

Personnel:

Excellent cooperation was obtained at all times from the ship's Master and crew, the B.C.F. scientist aboard (Fisheries Biologist Mr. Heeny Yuen), and the H.I.G. personnel both aboard and ashore.

The H.I.G. cruise personnel consisted of the writer; Mr. E. G. Gilley, research associate; Mr. Bruce Gottesburen, E. T.; Mr. Paul Patnode, E. E.

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Security Classification

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4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

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5. AUTHOR(S) (Last name, first name, initial)

Latham, Richard C.; Budd, Romondt; Zachariadis, Robert G.

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b. PROJECT NO.	
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	Office of Naval Research

13. ABSTRACT

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The report entitled "Oceanographic Parameters for Acoustical Determination Between Latitude 22°N and 30°N Along the 157°50' West Meridian" described a one-year environmental study made between May 1968 and April 1969. This interim report describes the work accomplished from May 1969 through October 1969.

The results of five ship cruises are reported which confirm the variability of the near-surface ocean environment in the area. A definite temperature inversion in the deep ocean below about 3800 meters depth is described. Several bathymetric profiles are presented, the results of current observations near the Sea Spider site are reported and the results from analysis of three cores taken by USNS SANDS at the Sea Spider site are reported.

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Oceanographic Observations						
Variability						
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